

CR-171 742
C-1

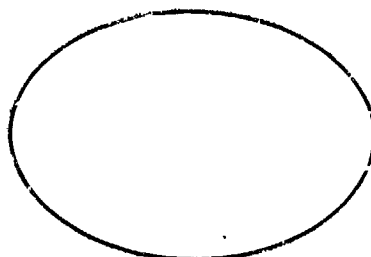
(NASA-CR-171742) SPACE SHUTTLE ICE
SUPPRESSION SYSTEM VALIDATION, VOLUME 3
Final Report (Texas A&M Univ.) 171 p
HC A08/1 A01

N84-17246

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G3/16 18331



TEXAS ENGINEERING EXPERIMENT STATION

The Texas A&M University System

College Station, Texas 77843

SPACE SHUTTLE ICE SUPPRESSION
SYSTEM VALIDATION
TEES-TR-4587-82-01
VOLUME III

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AEROSPACE ENGINEERING DEPARTMENT
AND
T.C. POLLOCK
ENGINEERING DESIGN AND GRAPHICS DEPARTMENT

Prepared for
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Thermal Technology Branch
Houston, Texas 77058
Under Contract NAS 9-16443

Prepared by
Texas Engineering Experiment Station
Texas A&M University
College Station, Texas 77843

PRESSURE DATA

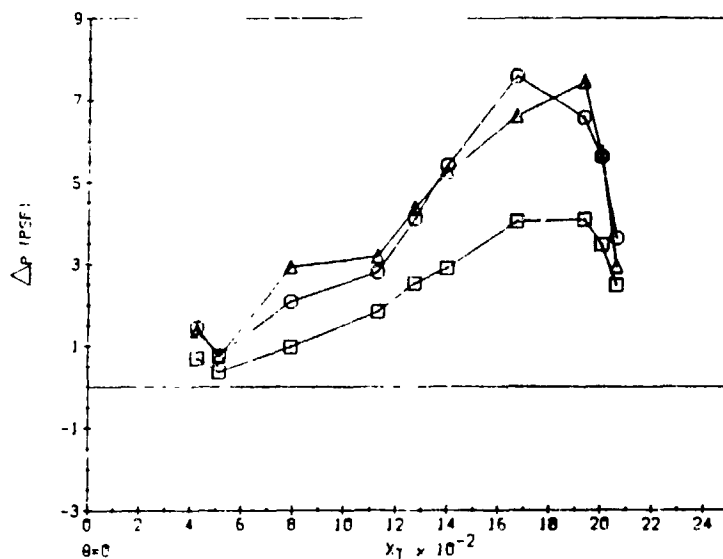
(4)

NOMINAL CONFIGURATION
GROUP I
INFLUENCE OF NOZZLE SIZE, NO WIND
RUNS 11, 12.1 and 13

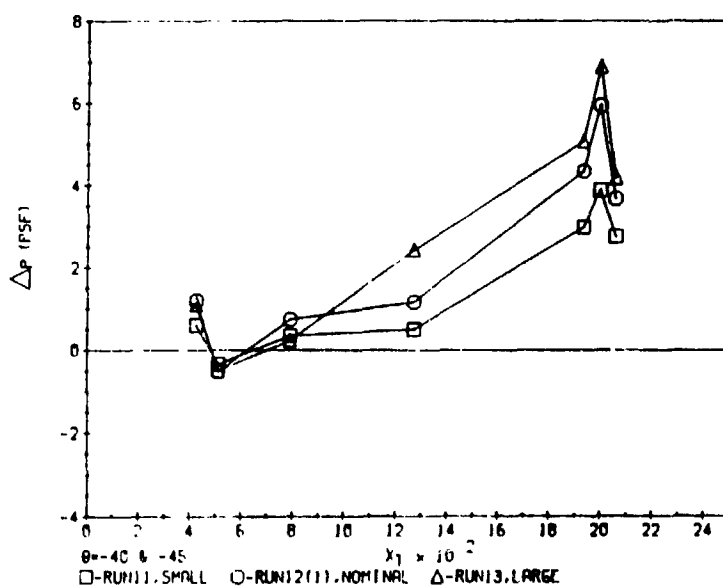
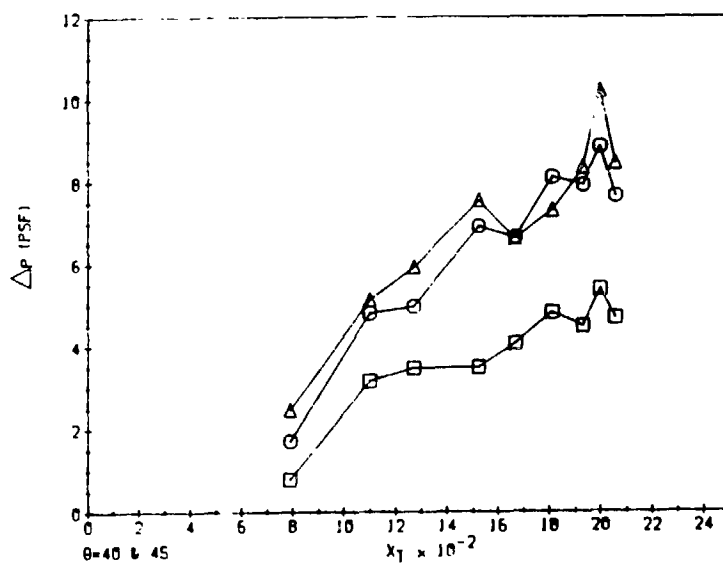
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$V = 0 \text{ KNOTS}$

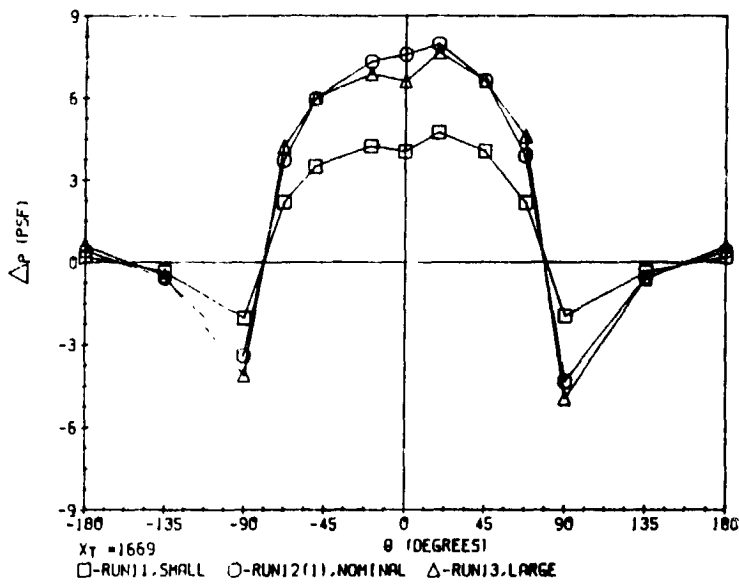
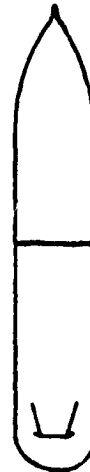
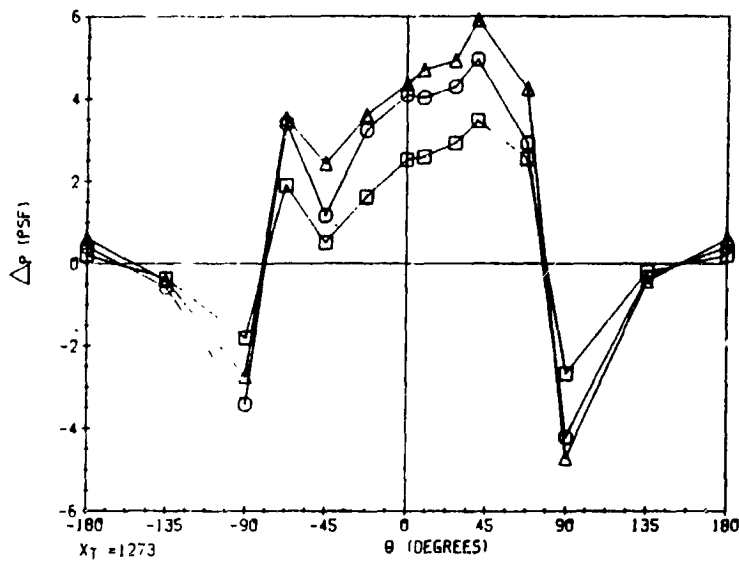
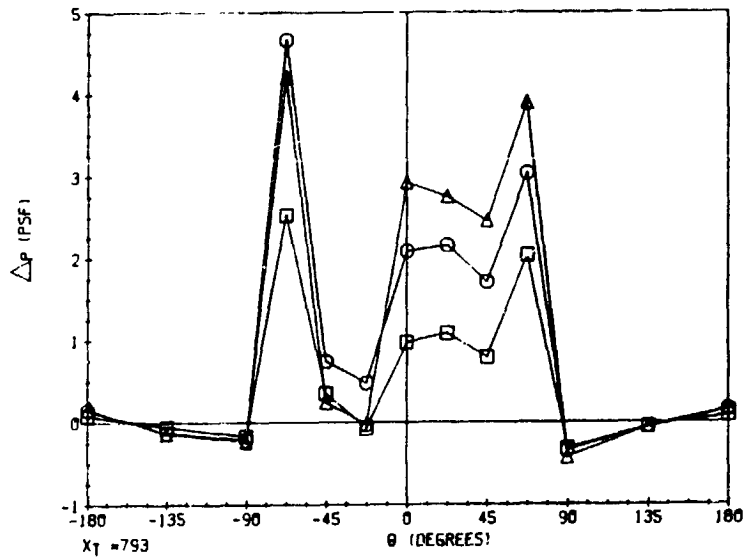
$\phi = 0^\circ$



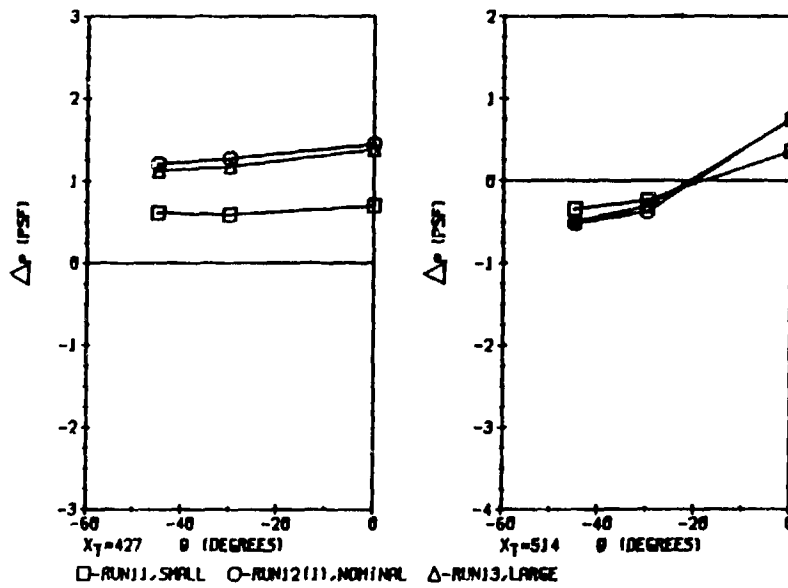
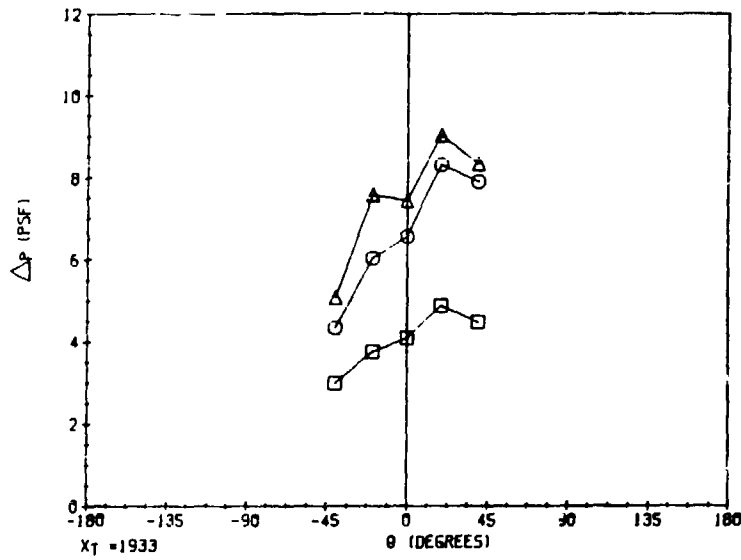
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NOMINAL CONFIGURATION
GROUP II
INFLUENCE OF NOZZLE SIZE ON WIND PENETRATION
RUNS 7, 9.1, 5 and 8

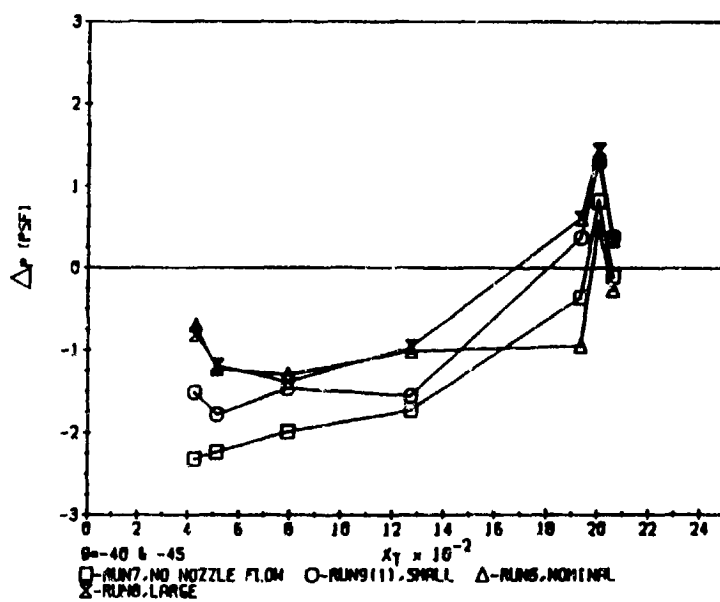
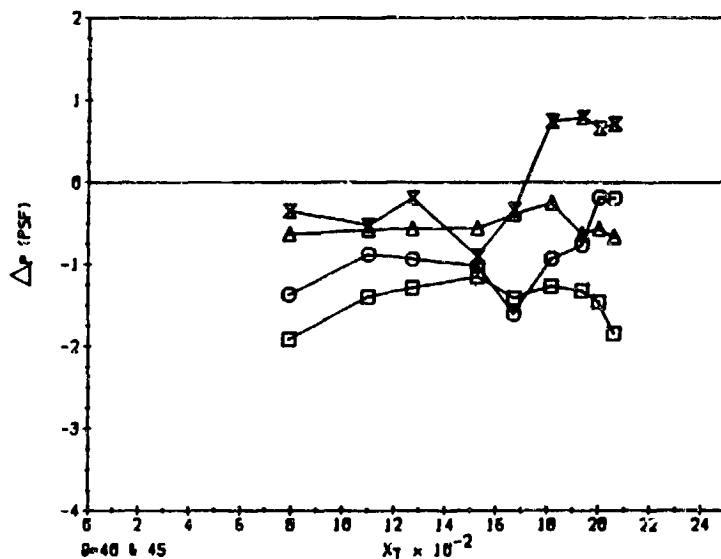
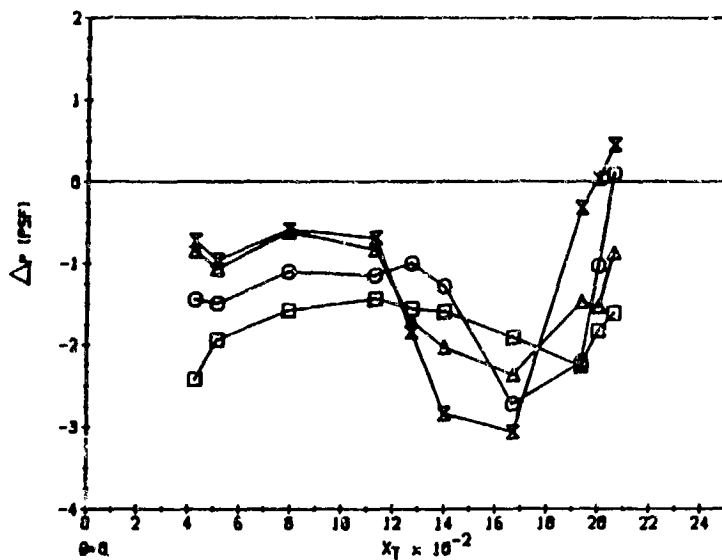
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$V = 20 \text{ KNOTS}$

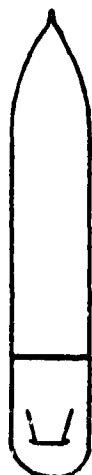
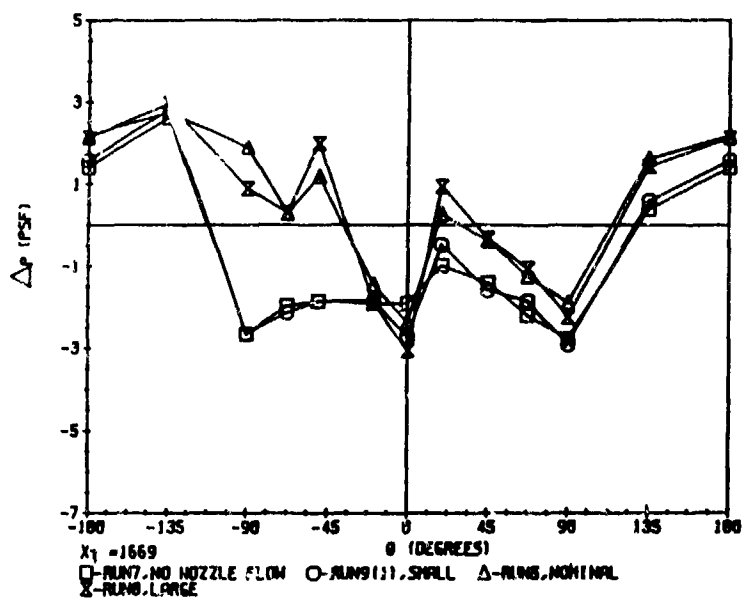
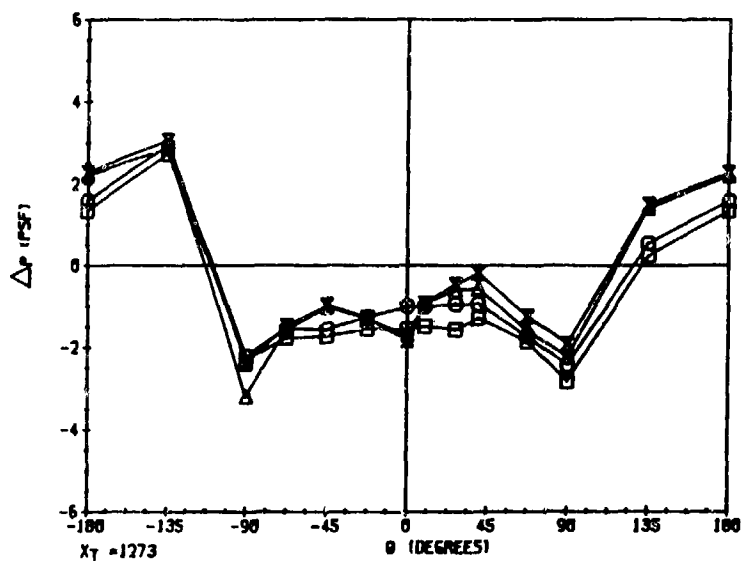
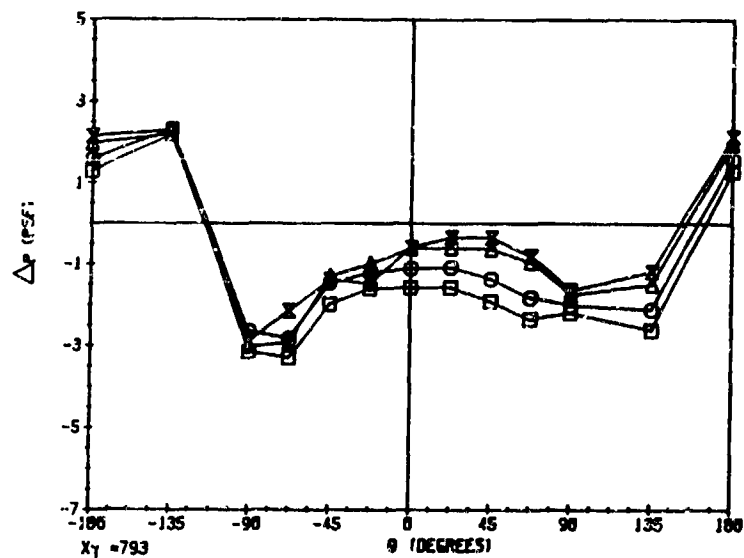
$\beta = 338^\circ$

$\phi = -30^\circ$

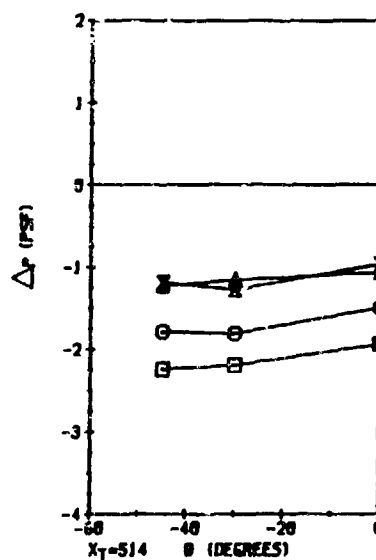
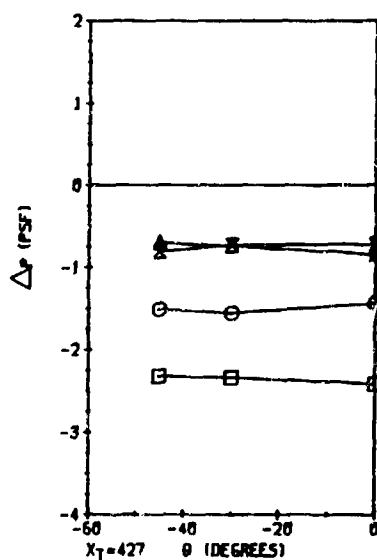
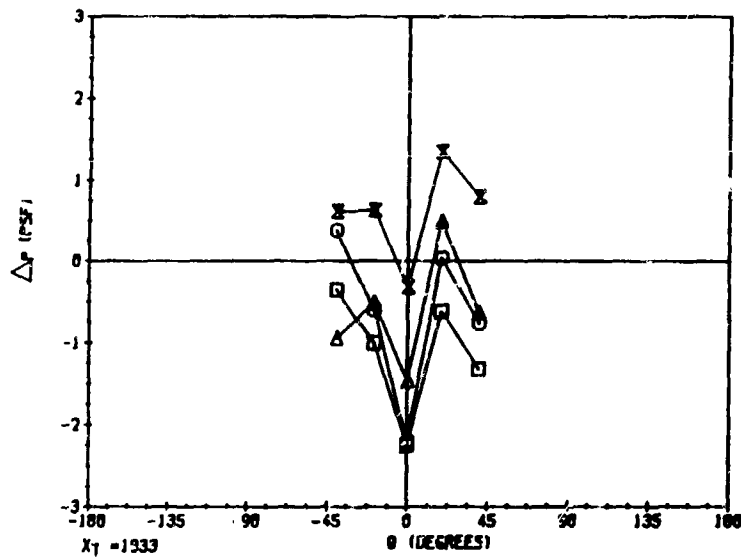
ORIGINAL QUALITY
OF POOR QUALITY



ORIGINAL PAGE 19
OF FOUR QUALITY



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OF POOR QUALITY



□-RUN7, NO NOZZLE FLOW ○-RUN9(1), SMALL △-RUN8, NOMINAL
X-RUN8, LARGE

NOMINAL CONFIGURATION

GROUP III

INFLUENCE OF NOZZLE PRESSURE ON WIND PENETRATION

RUNS 6.1, 6.2 and 6.3

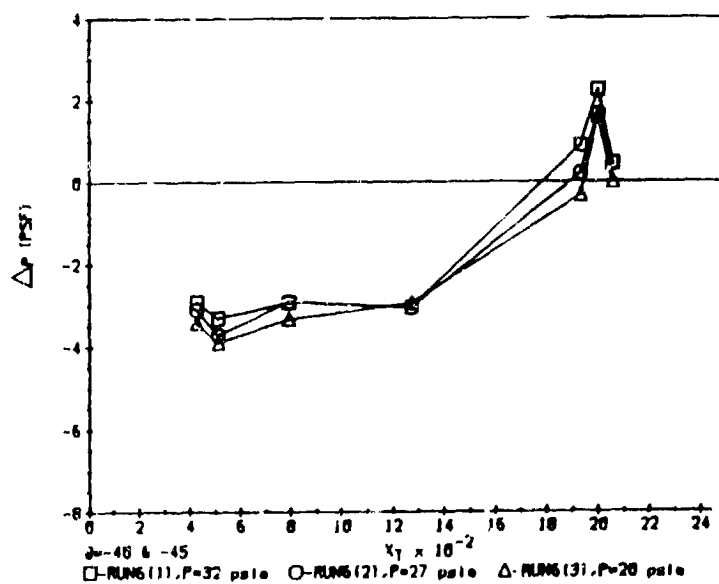
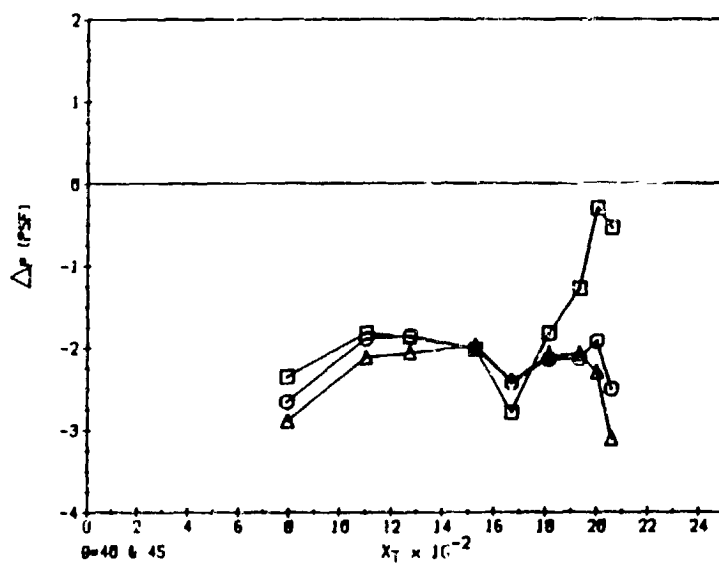
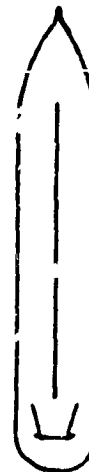
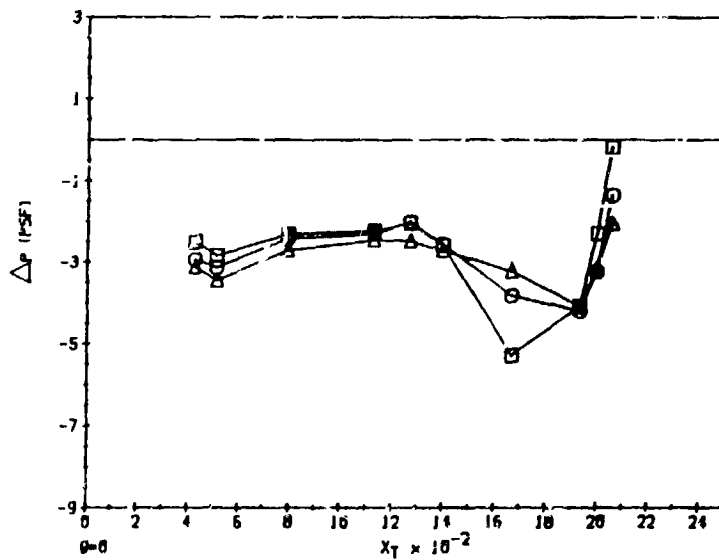
$V = 30$ KNOTS

$\beta = 336^\circ$

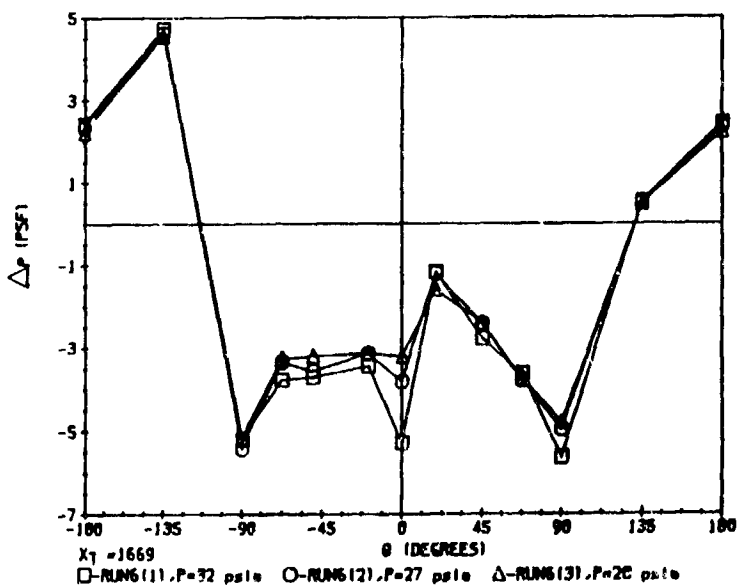
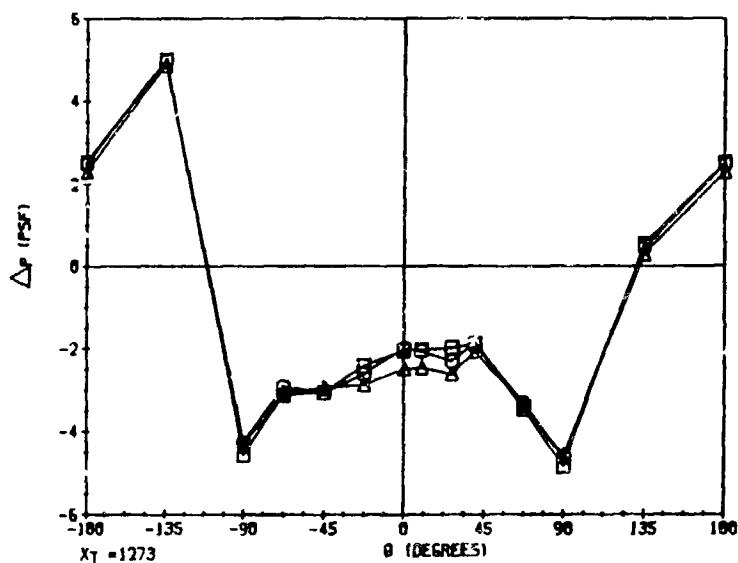
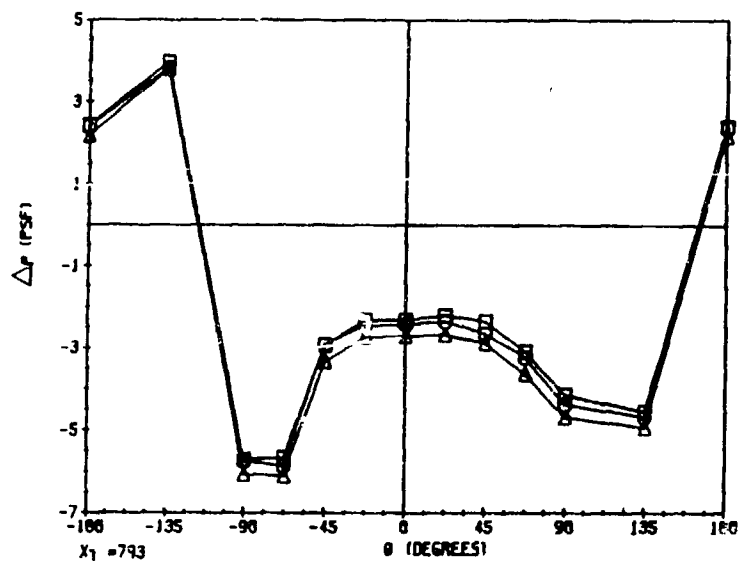
$\phi = 0^\circ$

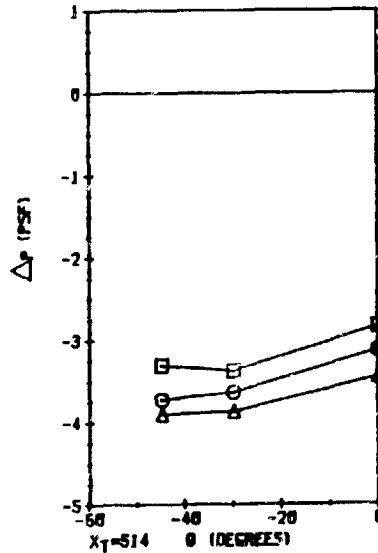
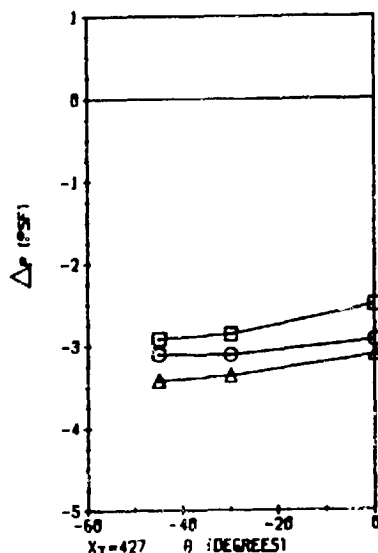
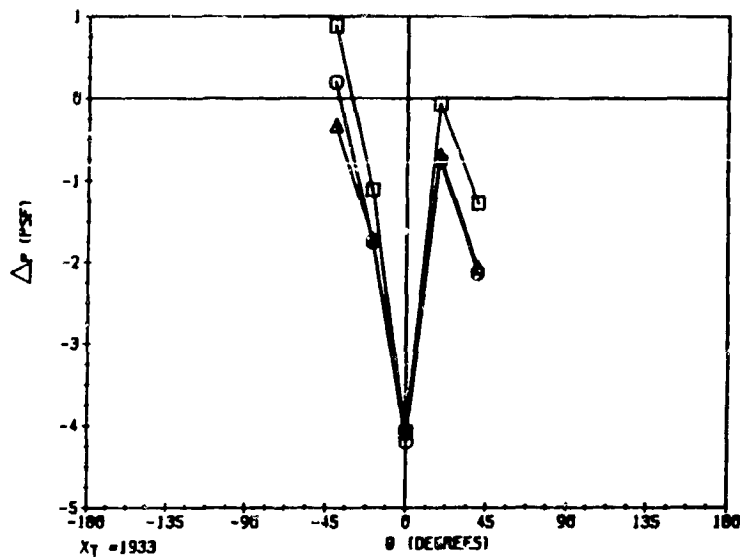
Nominal Nozzles

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ORIGINAL PAGE 13
OF POOR QUALITY





□-RUN 6(1)-P=32 psia ○-RUN 6(2)-P=27 psia △-RUN 6(3)-P=26 psia

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OF POOR QUALITY

NOMINAL CONFIGURATION

GROUP IV

WIND VELOCITY EFFECTS AT 338°

RUNS 12.1, 3, 1 and 2

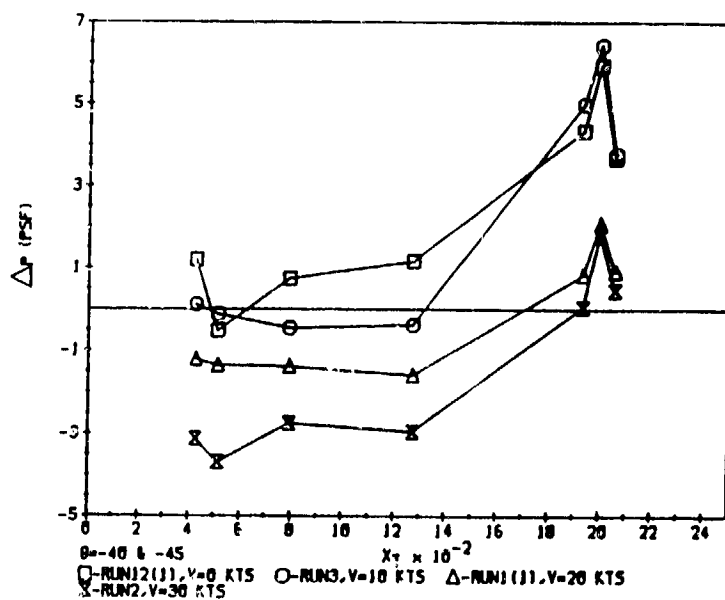
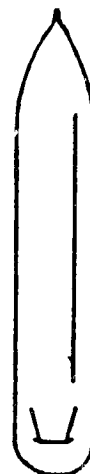
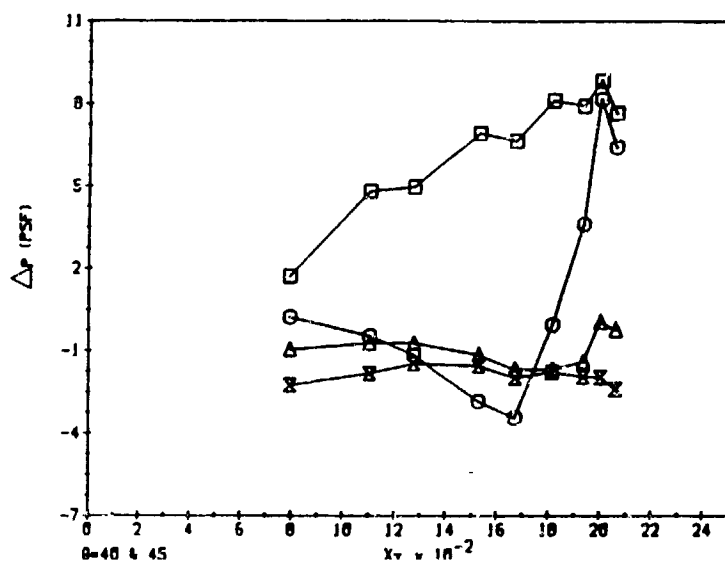
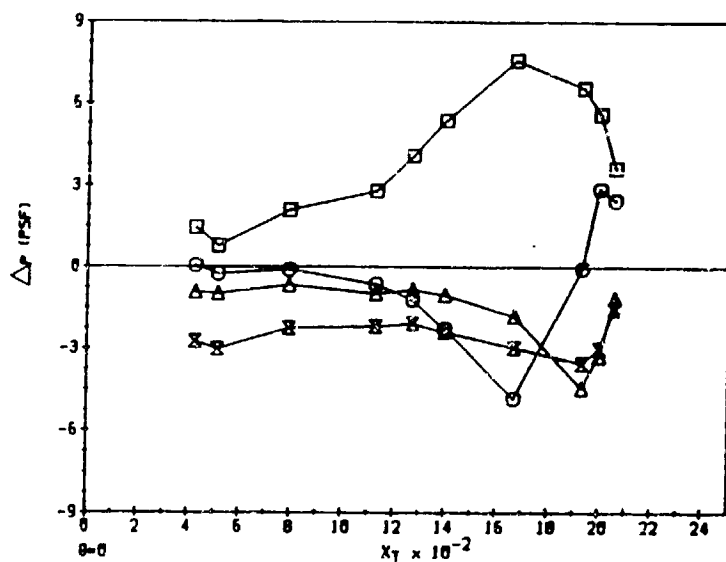
$$P = 32 \text{ psia}$$

$$\beta = 338^\circ$$

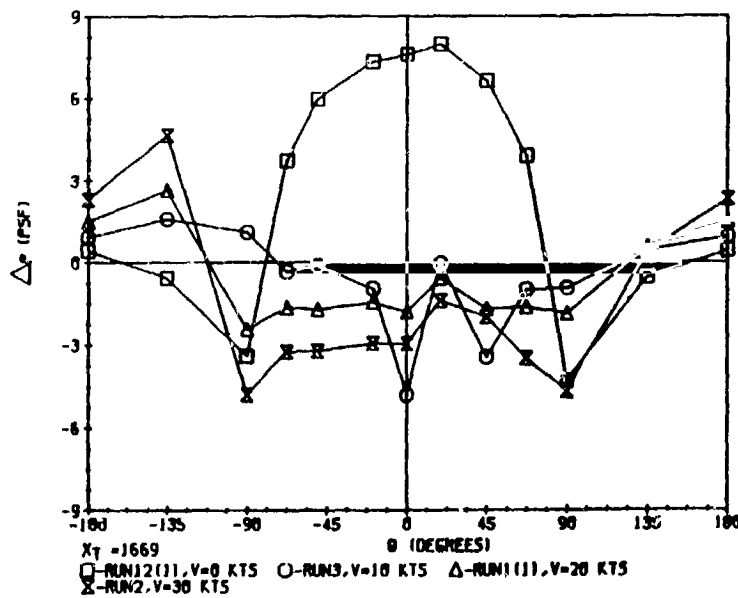
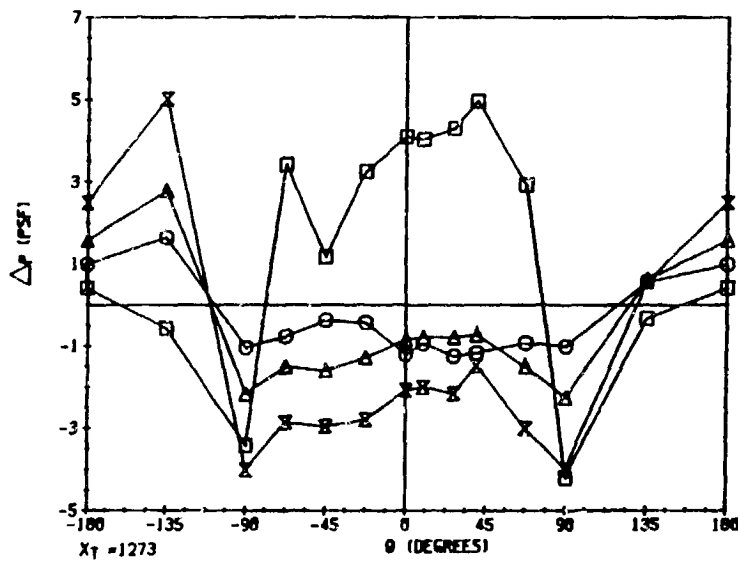
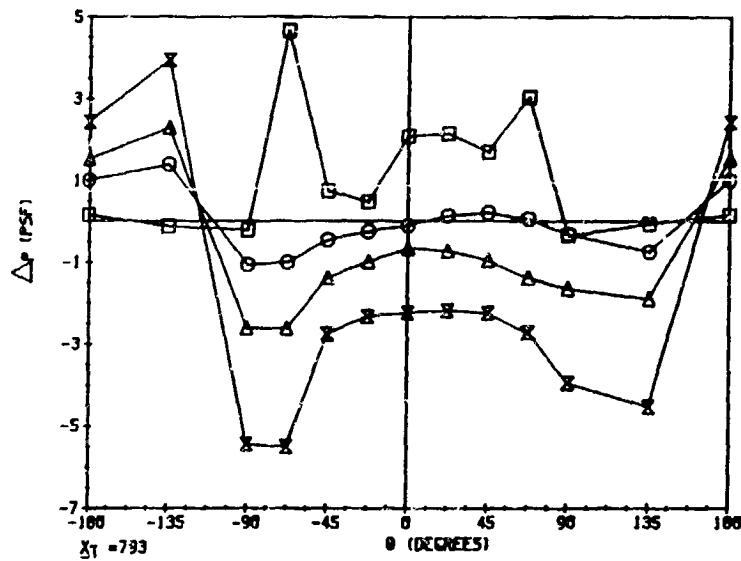
$$\phi = 0^\circ$$

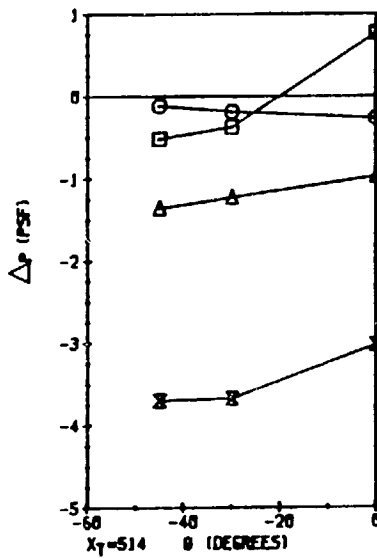
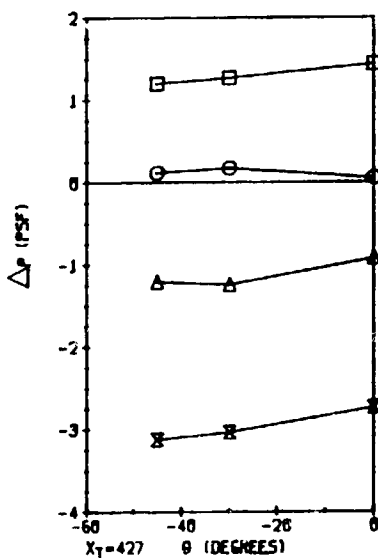
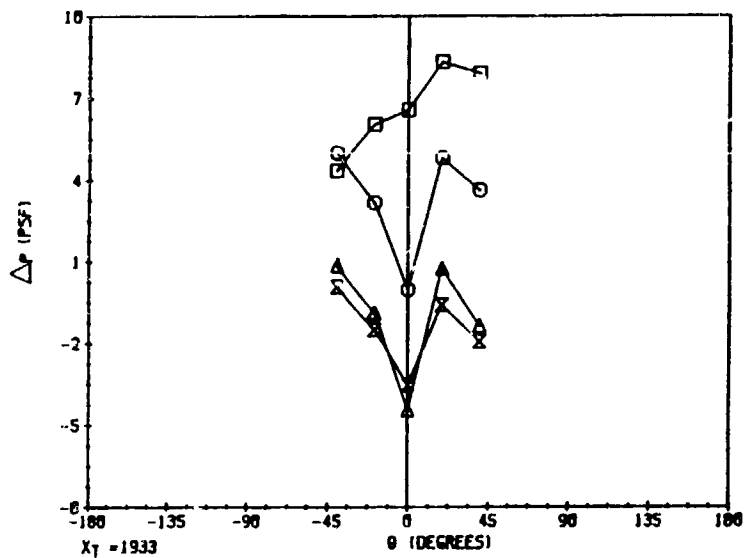
Nominal Nozzles

ORIGINAL PAGE 19
OF POOR QUALITY



ORIGINAL PAGE 13
OF POOR QUALITY





□-RUN1(1), V=0 KTS ○-RUN3, V=10 KTS △-RUN1(1), V=20 KTS
 ×-RUN2, V=30 KTS



ORIGINAL COPY
OF POOR QUALITY

NOMINAL CONFIGURATION

GROUP V

NOZZLE PRESSURE EFFECTS, NO WIND

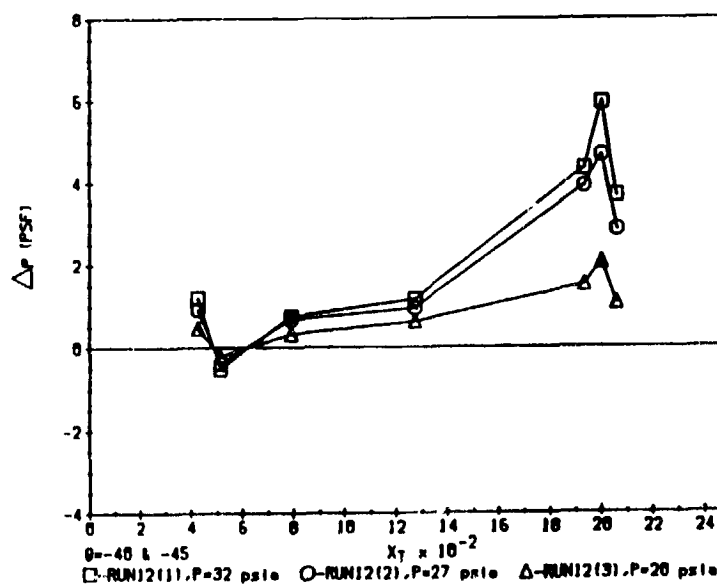
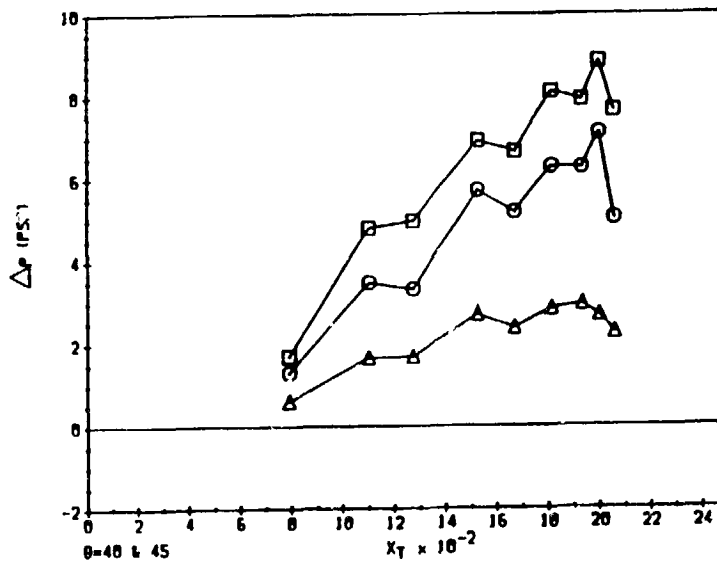
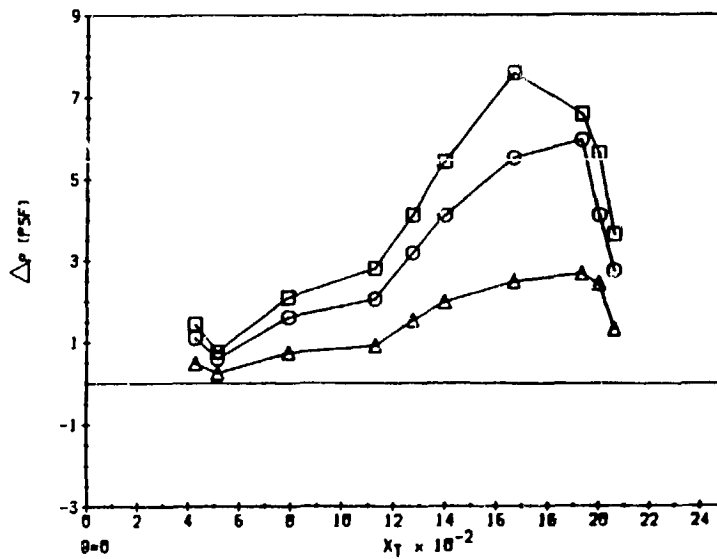
RUNS 12.1, 12.2 and 12.3

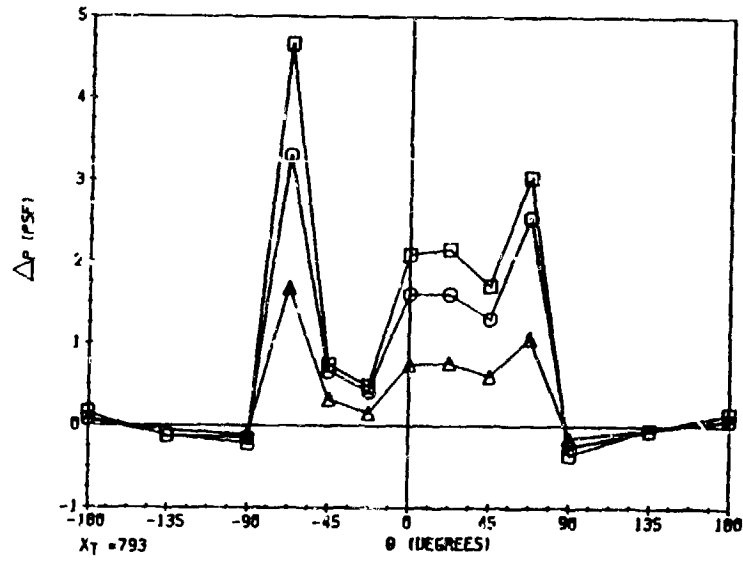
$V = 0$ KNOTS

$\phi = 0^\circ$

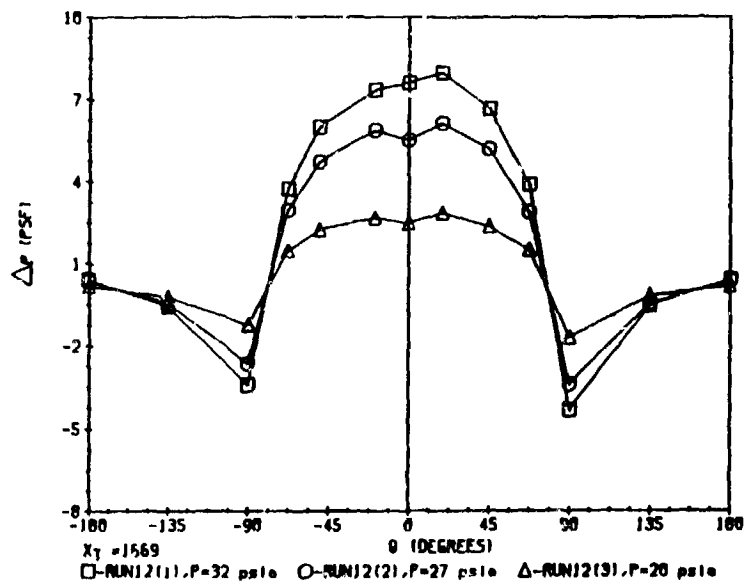
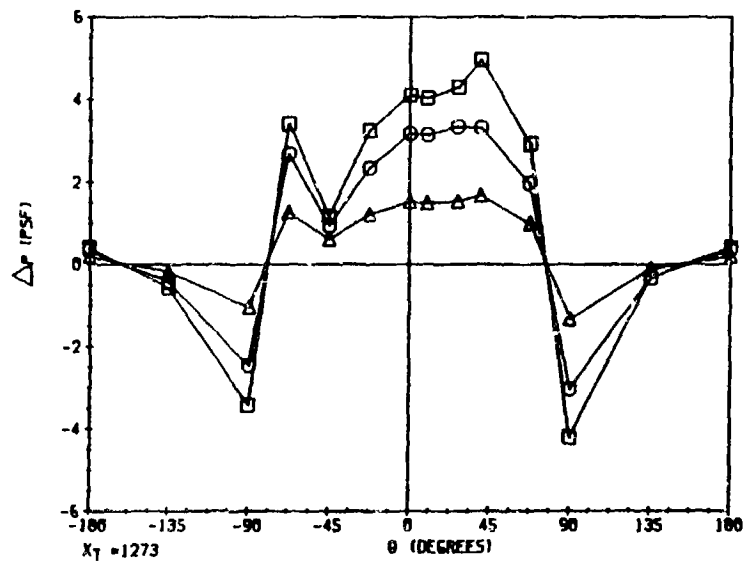
Nominal Nozzles

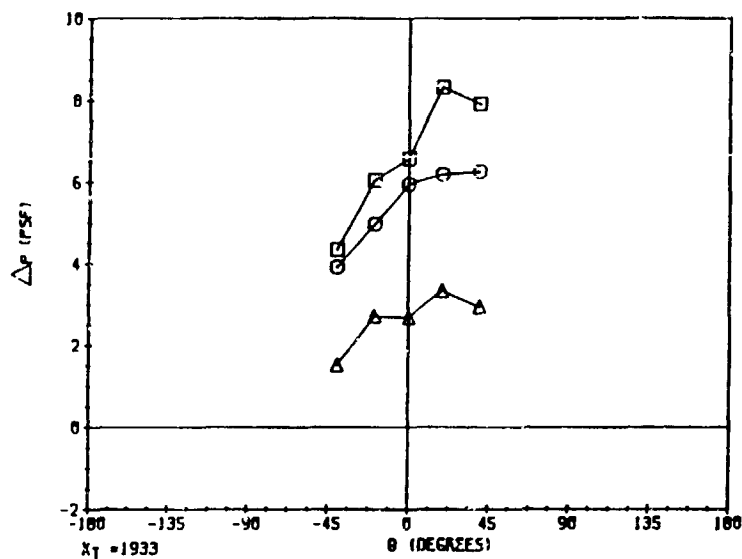
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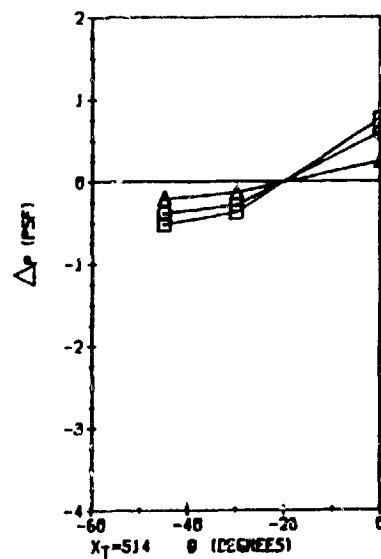
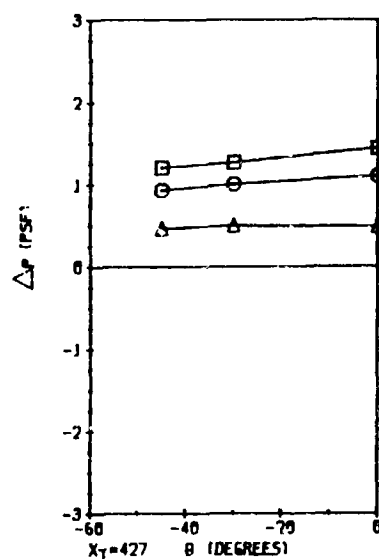


ORIGINAL FIGURE
OF POOR QUALITY





ORIENTATION
OF POOR QUALITY



□-RUN12(1), P=32 psia ○-RUN12(2), P=27 psia △-RUN12(3), P=26 psia



NOMINAL CONFIGURATION

GROUP VI

WIND VELOCITY EFFECTS AT 112°

RUNS 12.1, 17.1, 17.2, 17.3 and 17.4

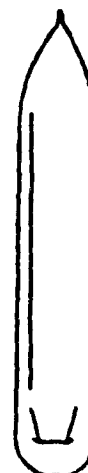
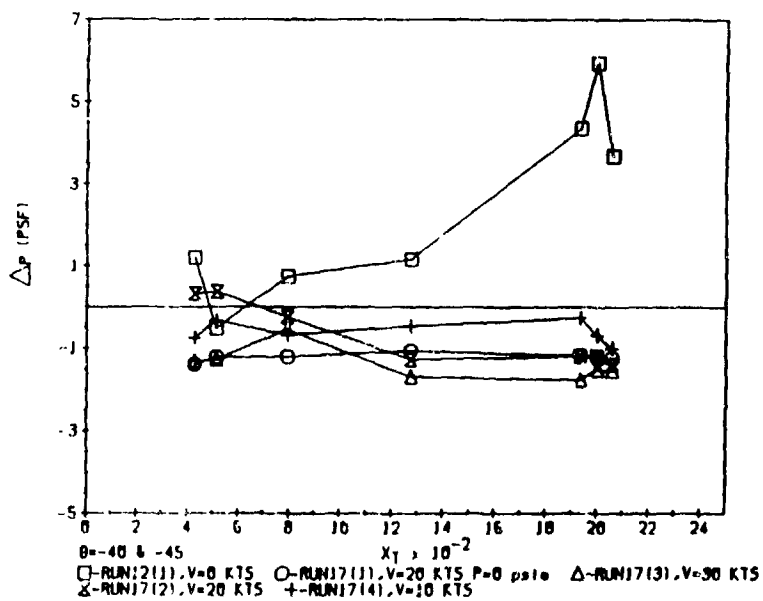
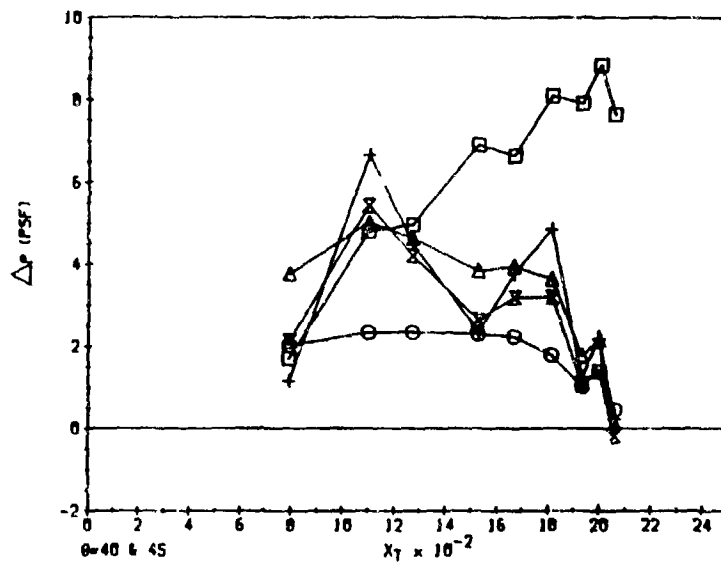
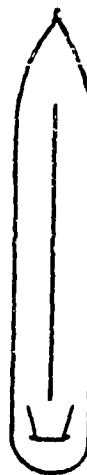
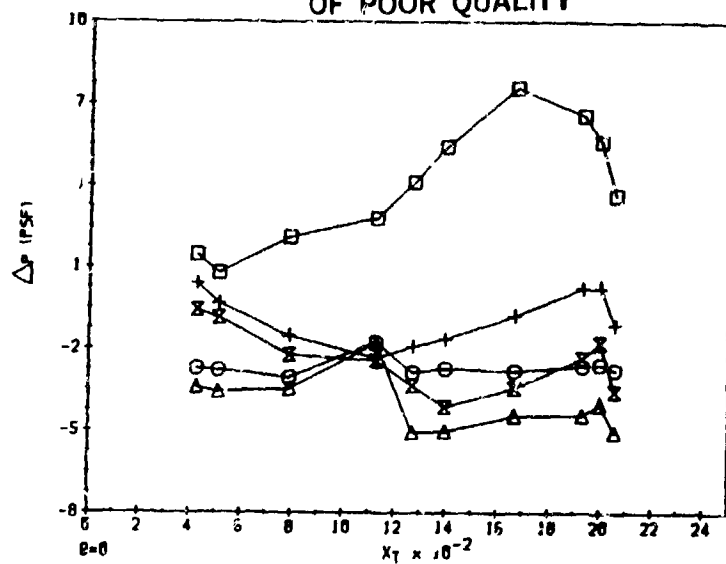
$P = 32 \text{ psia}$

$\beta = 112^\circ$

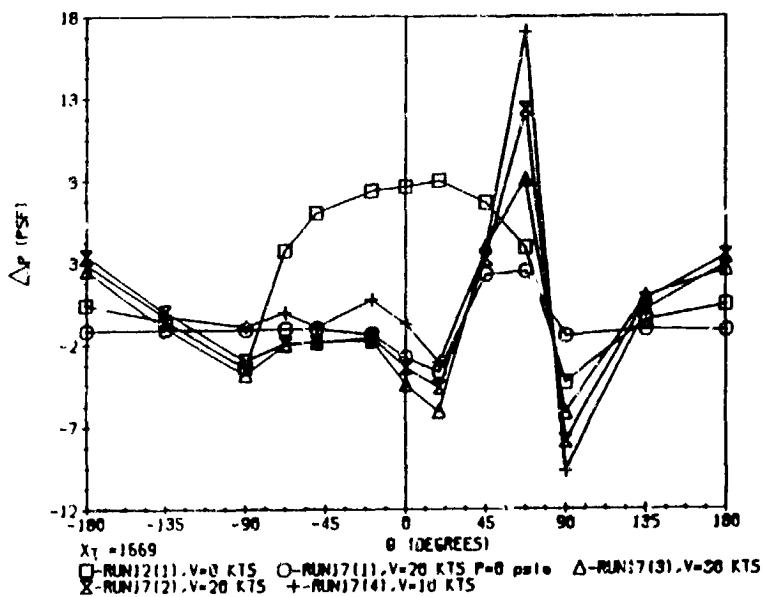
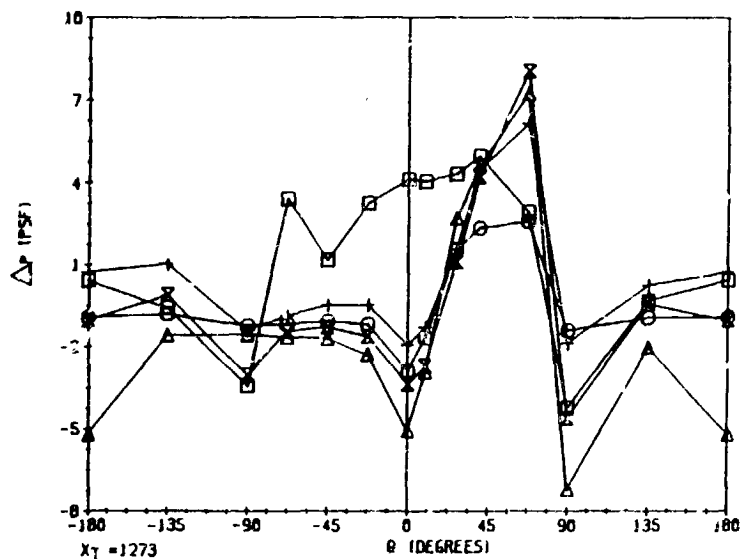
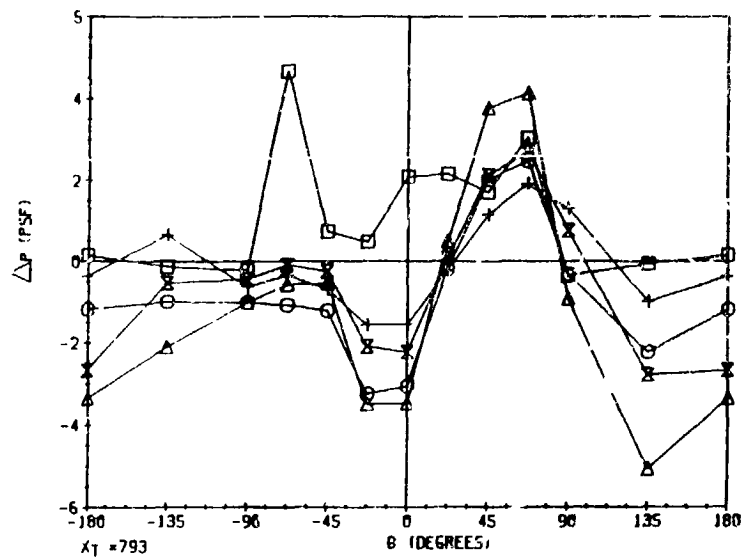
$\phi = 0^\circ$

Nominal Nozzles

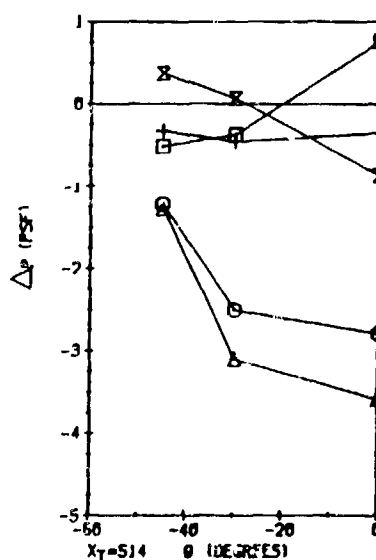
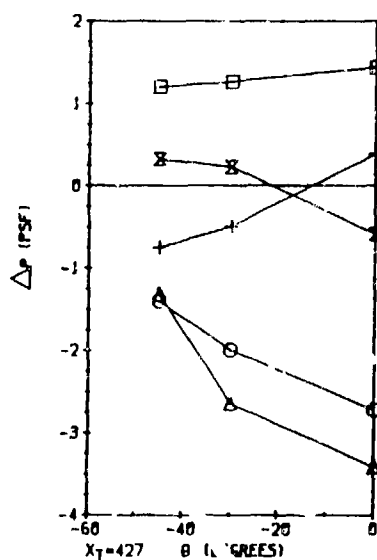
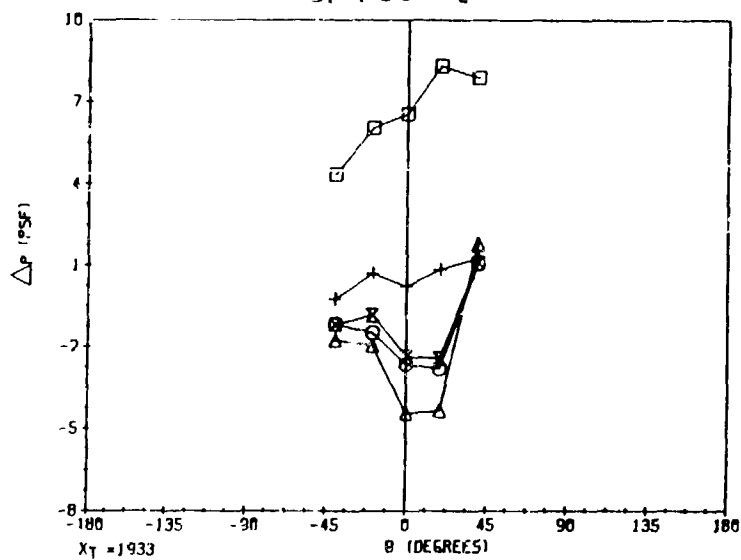
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\square - RUN 12(1), $V=0$ KTS
 \times - RUN 17(2), $V=20$ KTS
 \circ - RUN 17(1), $V=20$ KTS
 \triangle - RUN 17(3), $V=30$ KTS
 $+$ - RUN 17(4), $V=10$ KTS



NOMINAL CONFIGURATION

GROUP VII

NOMINAL VELOCITY EFFECTS AT 202°

RUNS 12.1, 14, 16.1, 15 and 16.2

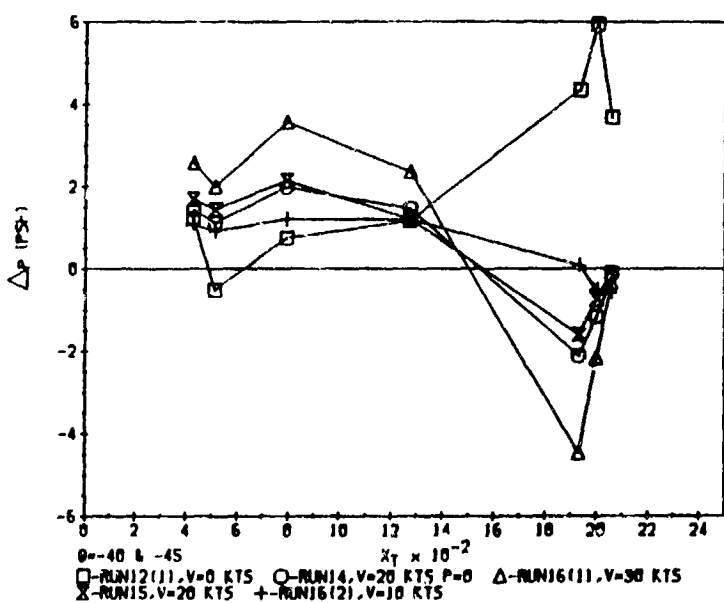
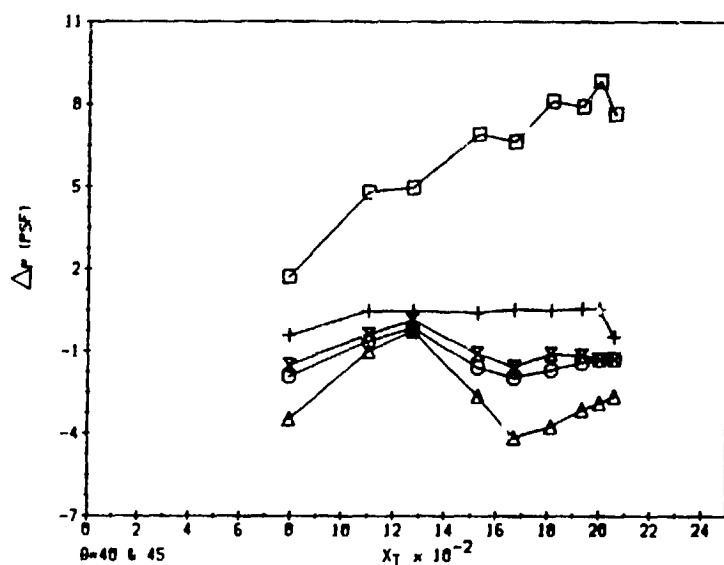
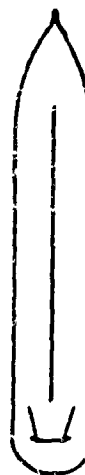
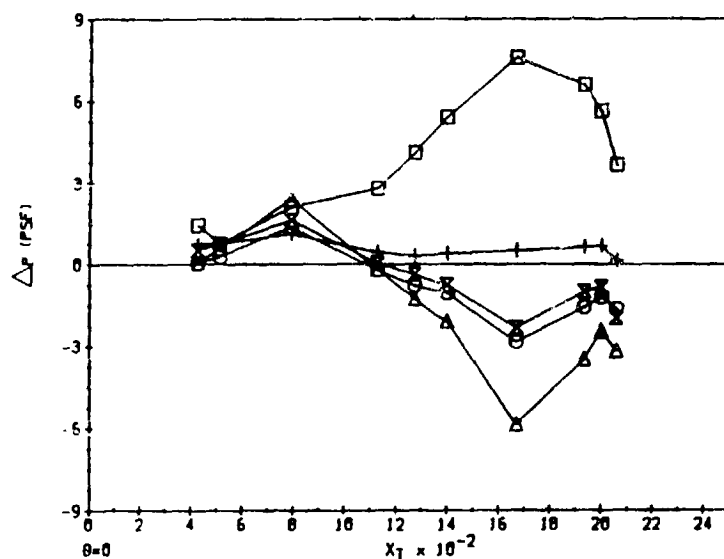
$$P = 32 \text{ psia}$$

$$\beta = 202^\circ$$

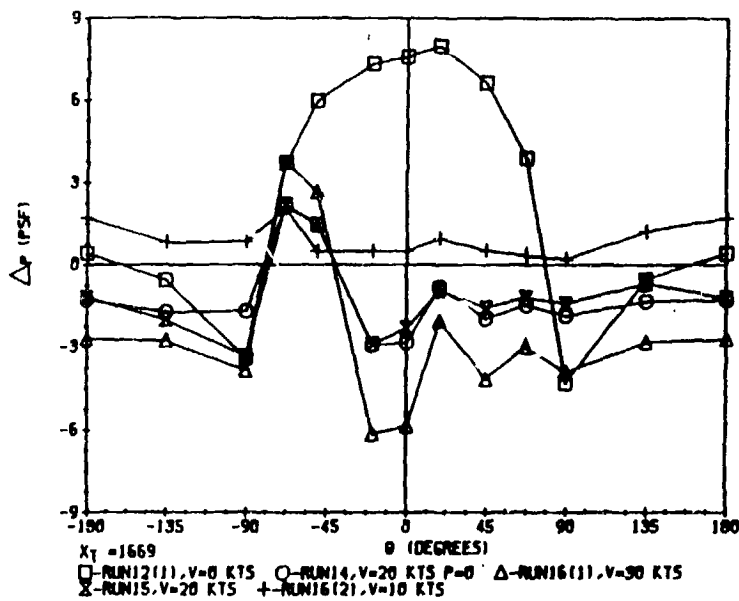
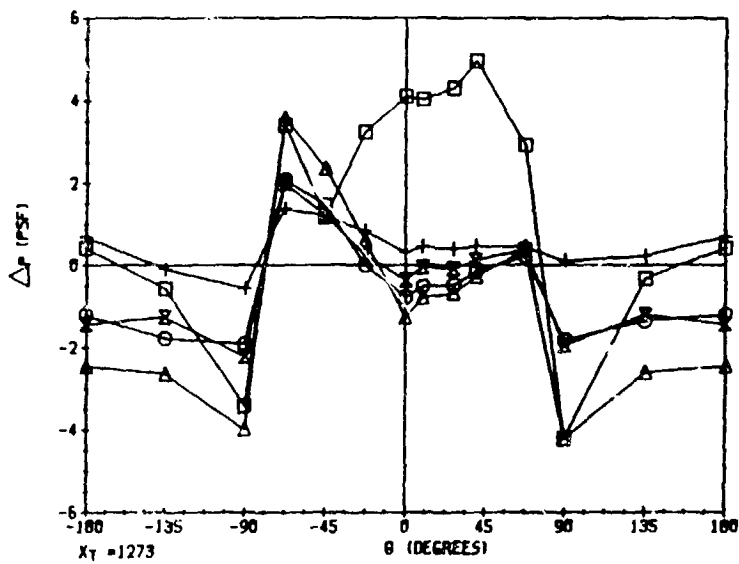
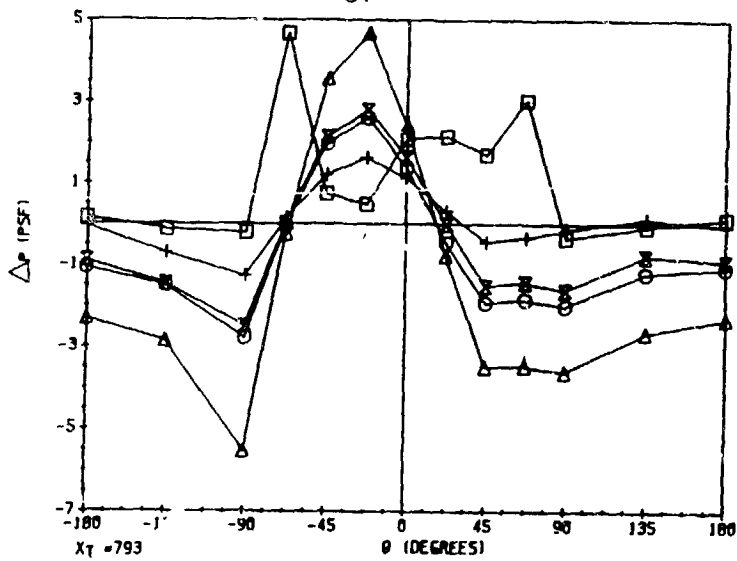
$$\phi = 0^\circ$$

Nominal Nozzles

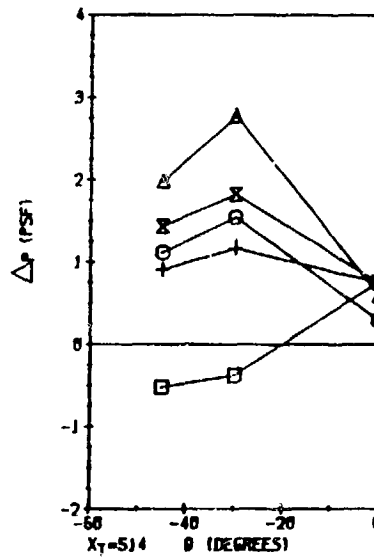
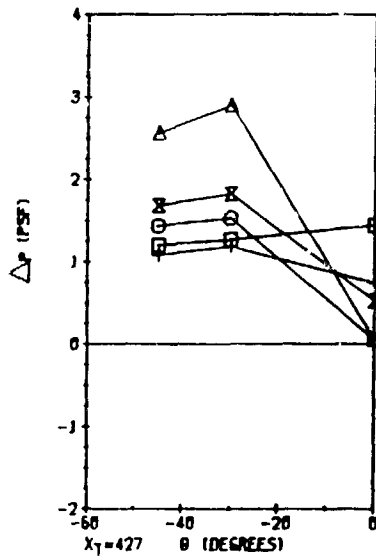
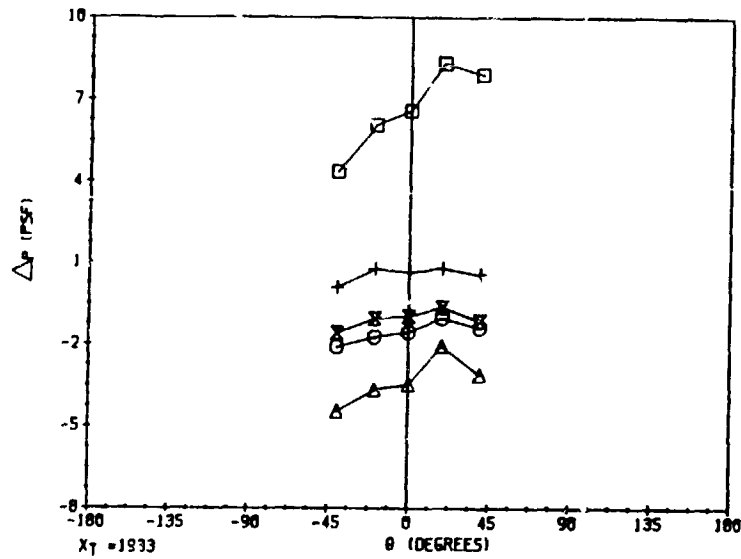
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ORIGINAL PAGE 19
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ORIGINAL PAGE 13
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\square - RUN 12(1), $V=0$ KTS \circ - RUN 14, $V=20$ KTS $P=0$ \triangle - RUN 16(1), $V=30$ KTS
 \times - RUN 15, $V=20$ KTS $+$ - RUN 16(2), $V=10$ KTS

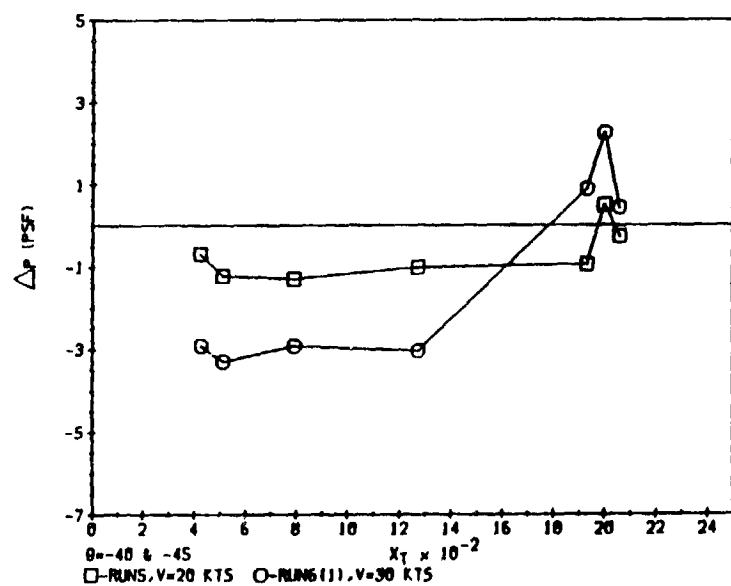
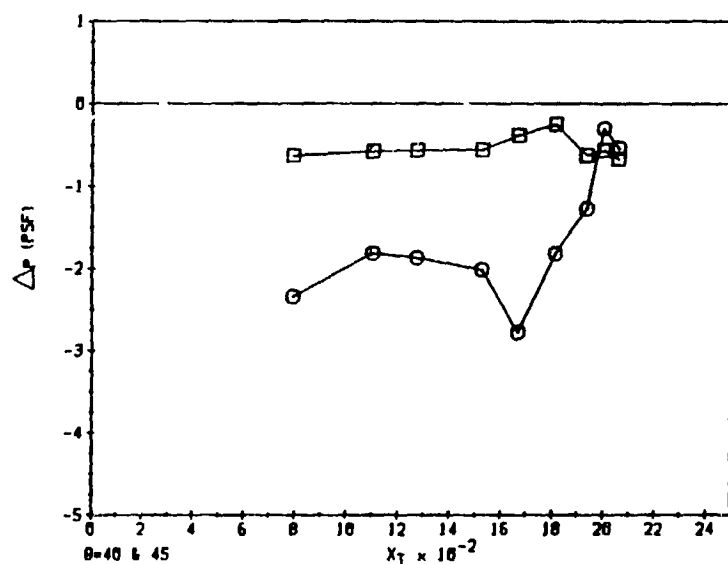
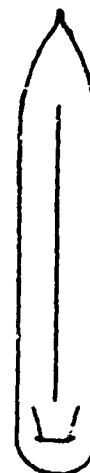
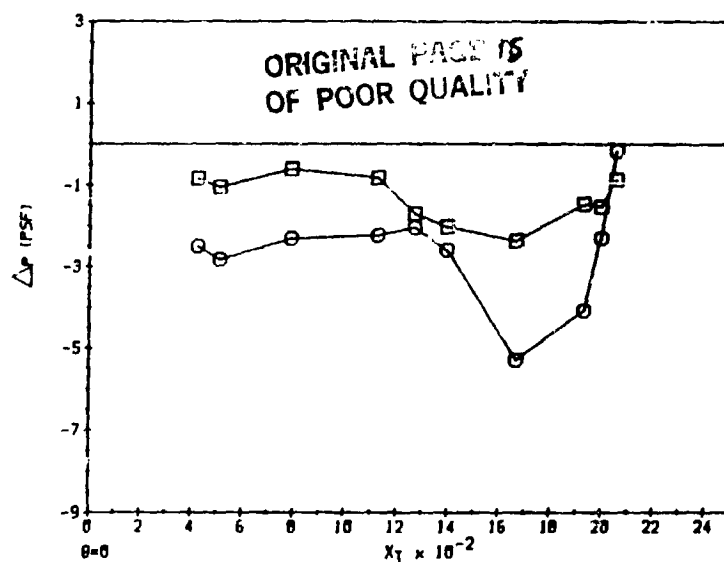
NOMINAL CONFIGURATION
GROUP VIII
WIND VELOCITY EFFECTS ON WIND PENETRATION
RUNS 5 and 6.1

$P = 32 \text{ psia}$

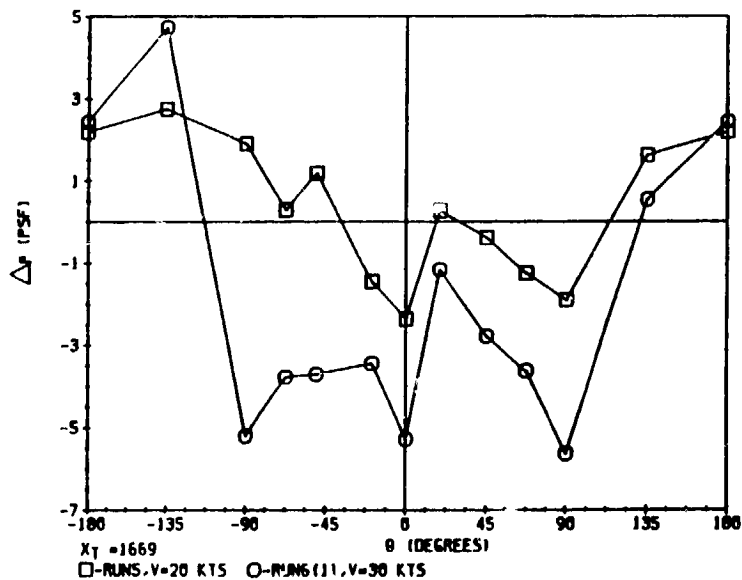
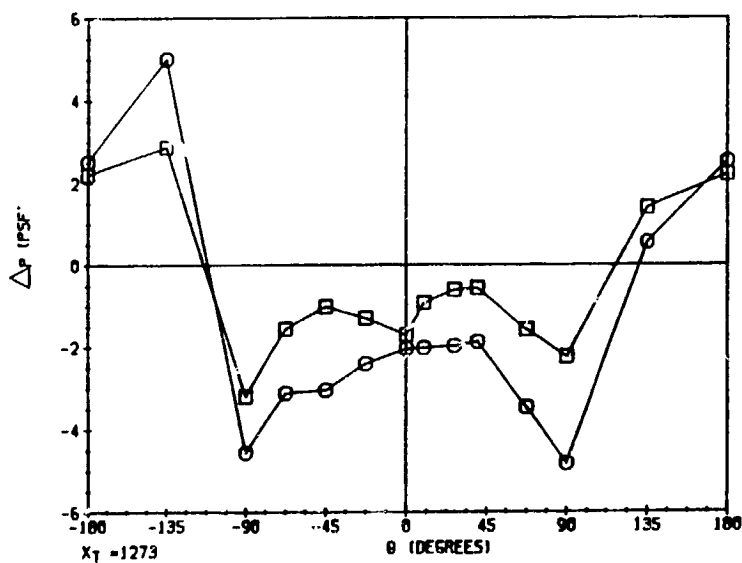
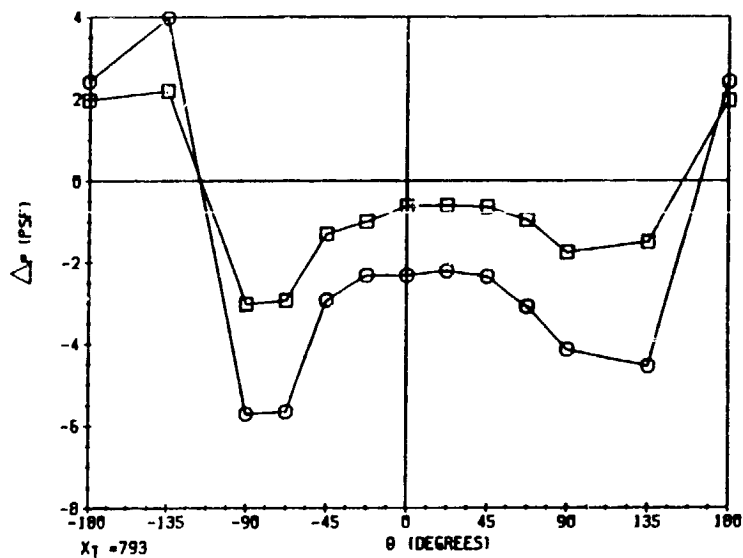
$\beta = 338^\circ$

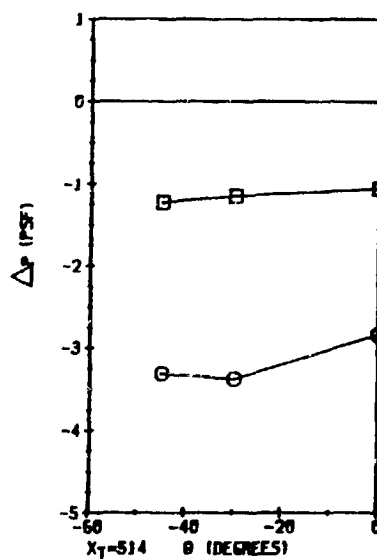
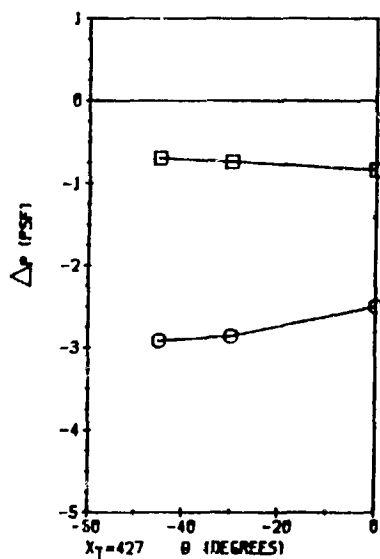
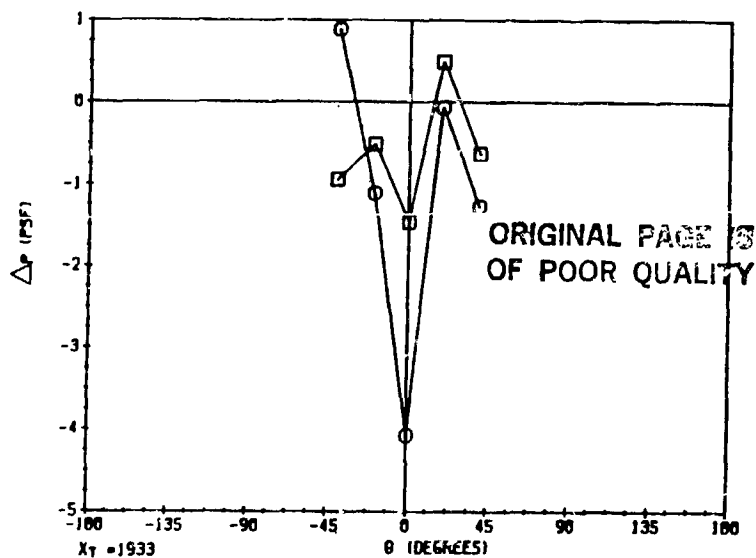
$\phi = -30^\circ$

Nominal Nozzles



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OF POOR QUALITY





□-RUN5, V=20 KTS ○-RUN6(1), V=30 KTS

NOMINAL CONFIGURATION

GROUP IX

NOZZLE AZIMUTH ANGLE EFFECTS

RUNS 1.1, 4 and 5

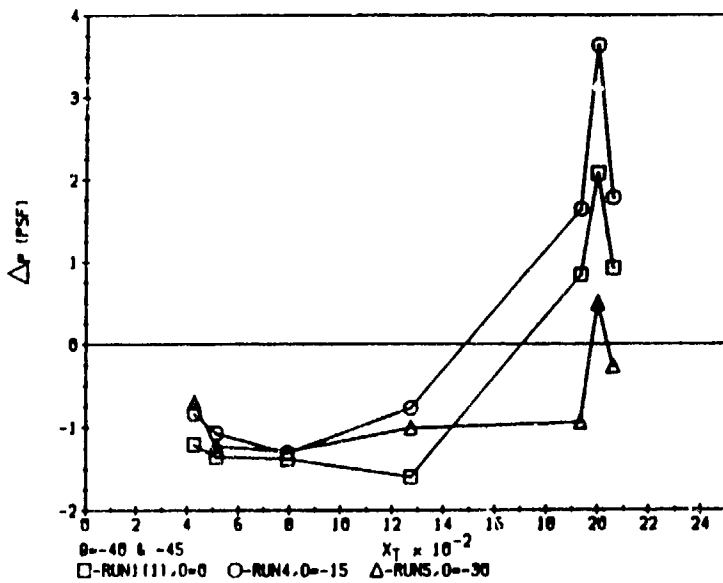
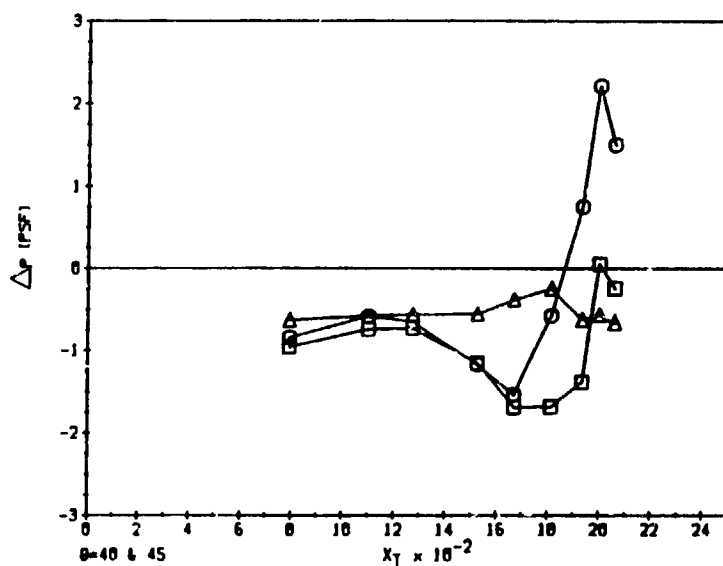
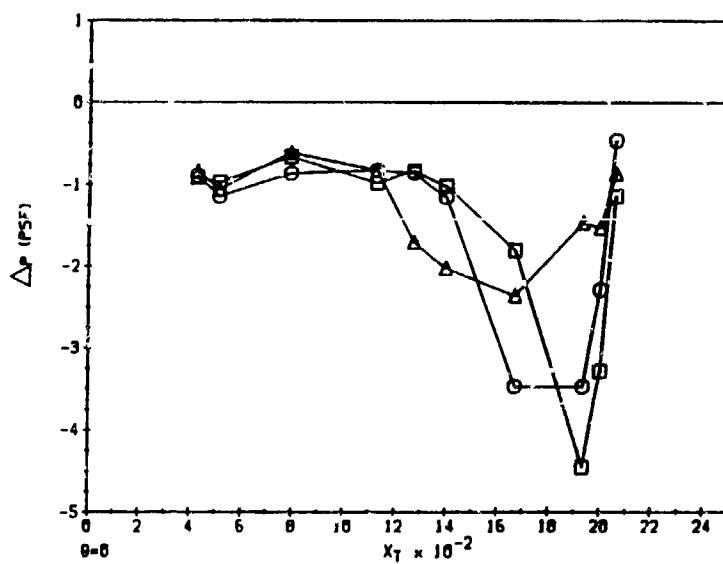
$P = 32 \text{ psia}$

$V = 20 \text{ KNOTS}$

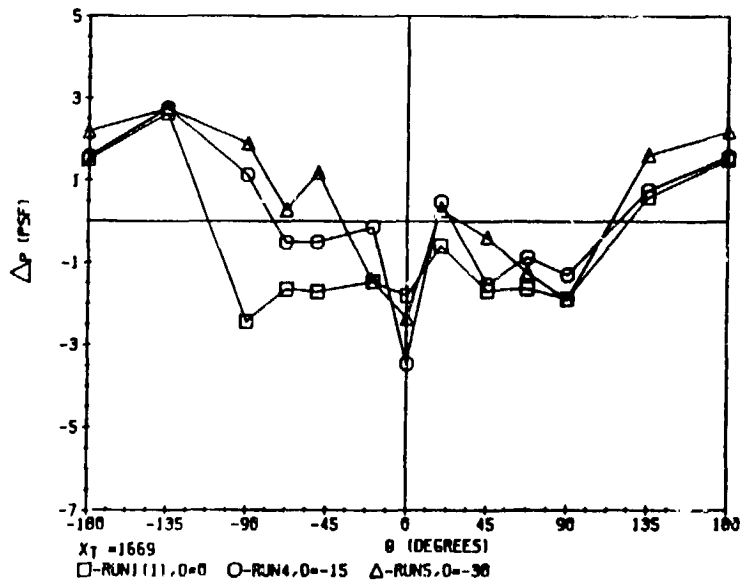
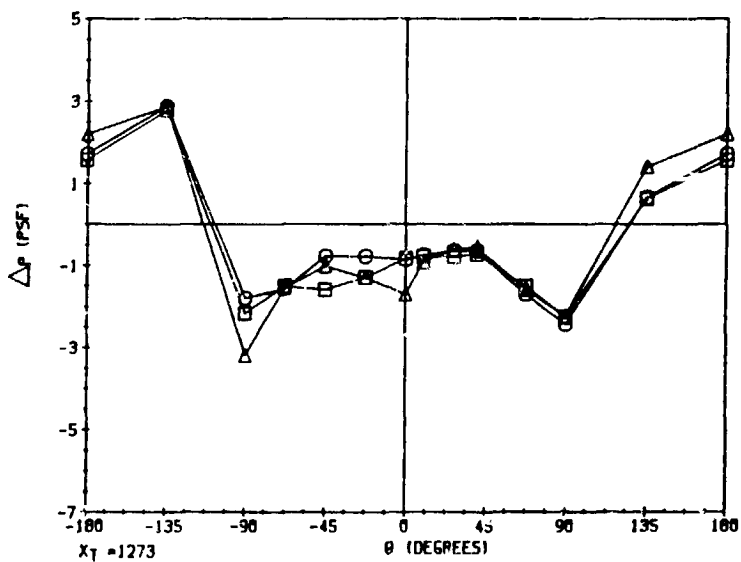
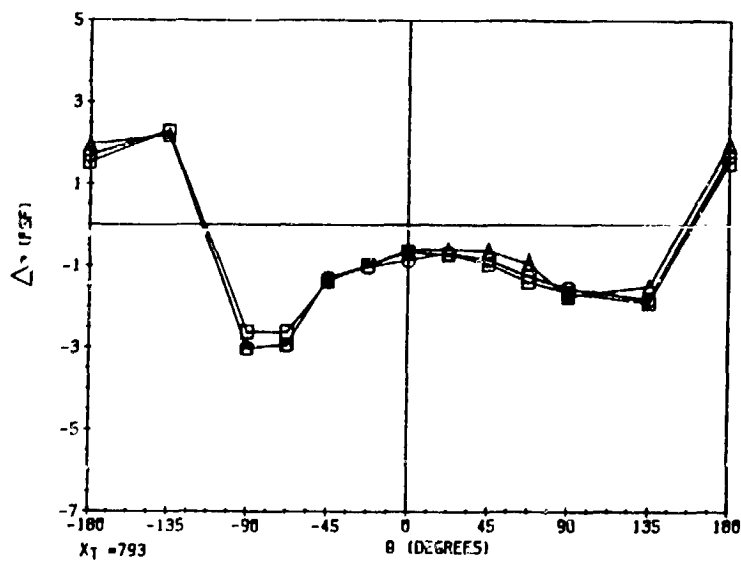
$\beta = 338^\circ$

Nominal Nozzles

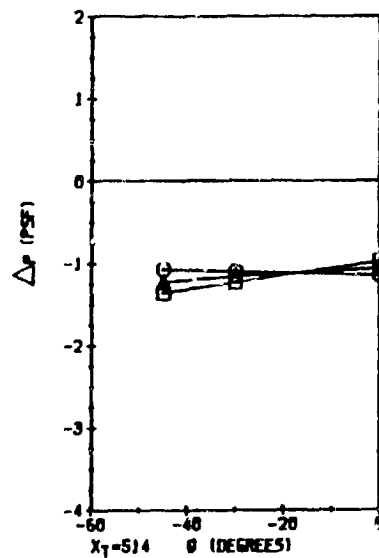
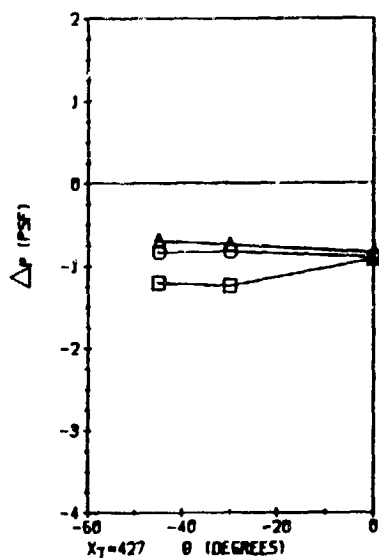
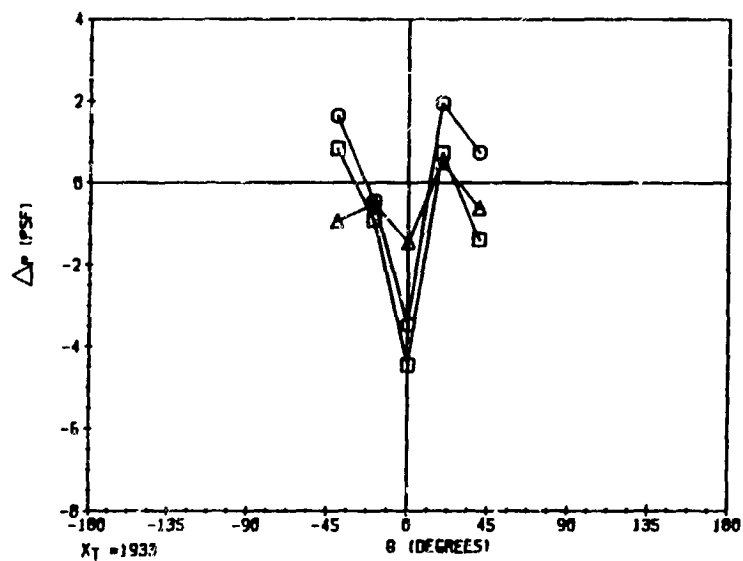
ORIGINAL PAGE 13
OF POOR QUALITY



theta = 40 & 45
 □ - RUN 1, theta = 0
 ○ - RUN 4, theta = -15
 △ - RUN 5, theta = -30



ORIGINAL PAGE IS
OF POOR QUALITY



□-RUN1, $\theta=0$ ○-RUN4, $\theta=-15$ Δ-Run5, $\theta=-30$

VARIABLE NOZZLE SIZE CONFIGURATION

GROUP X

NOZZLE PRESSURE EFFECTS

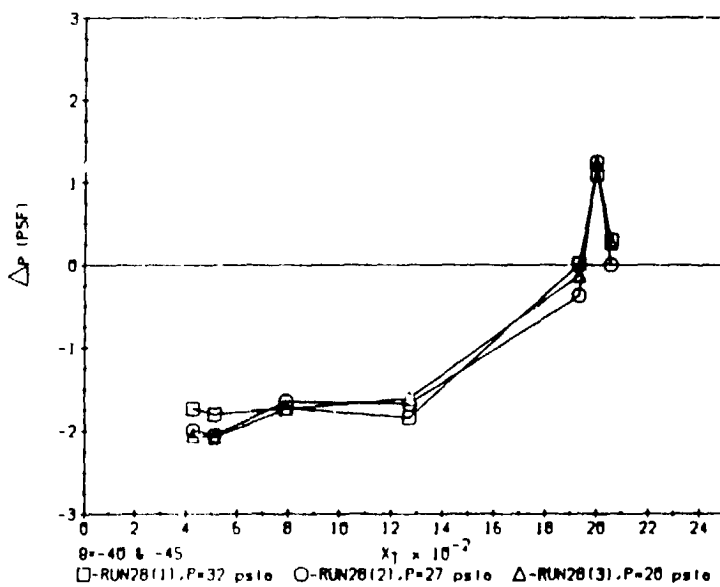
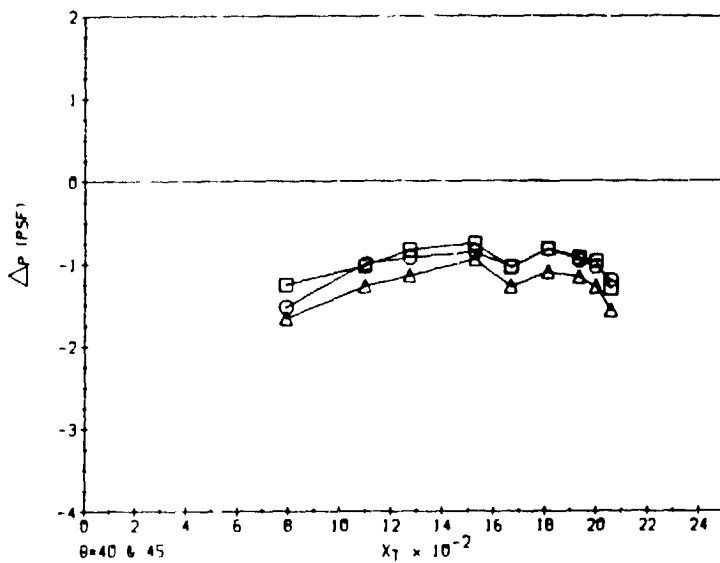
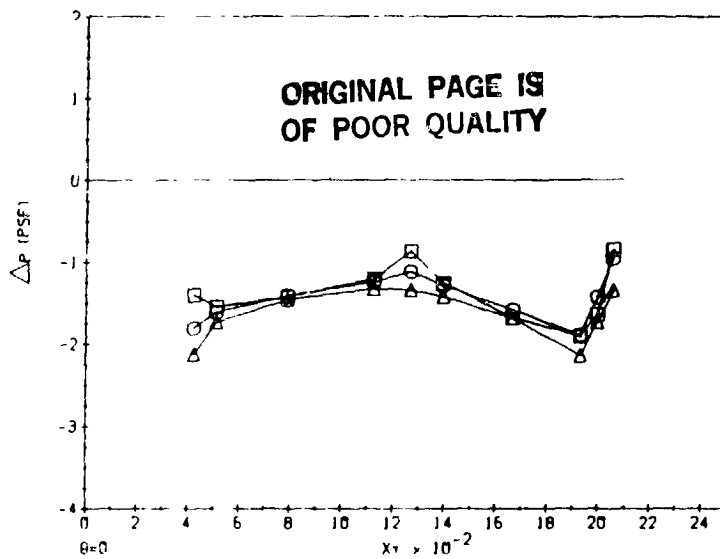
RUNS 28.1, 28.2 and 28.3

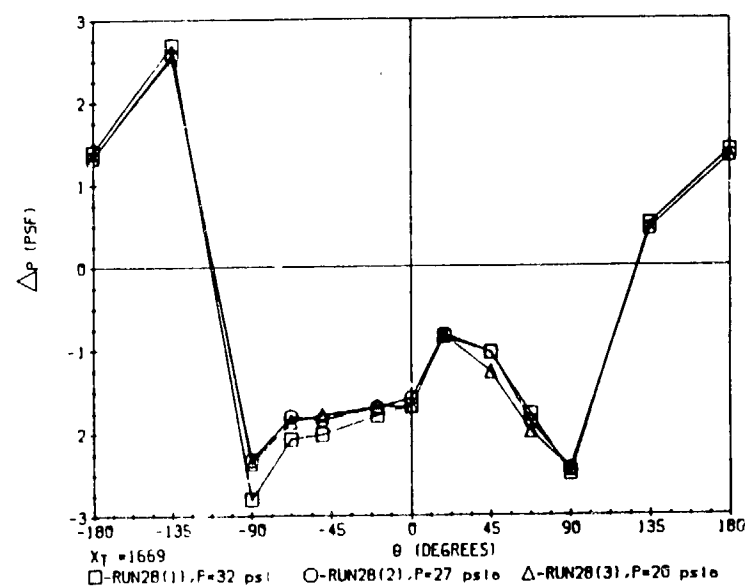
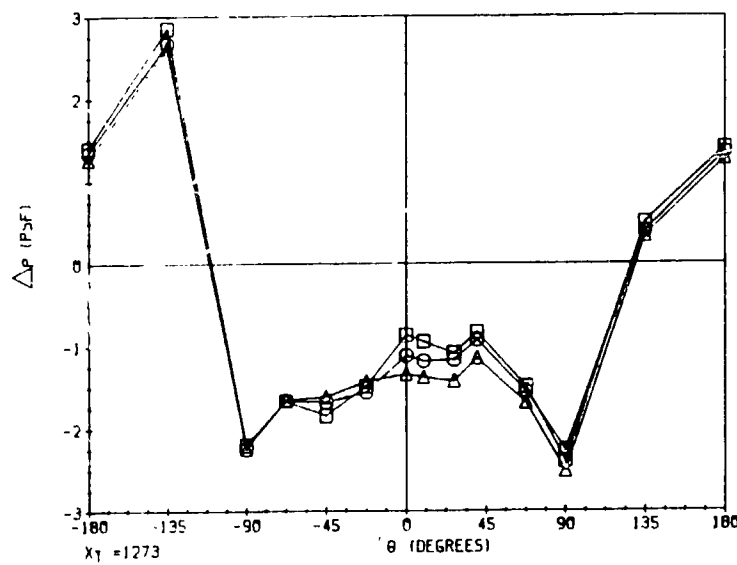
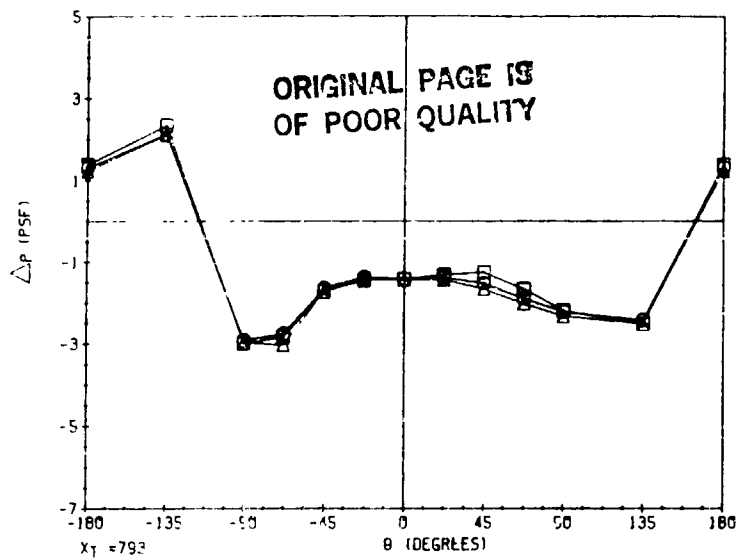
$V = 20$ KNOTS

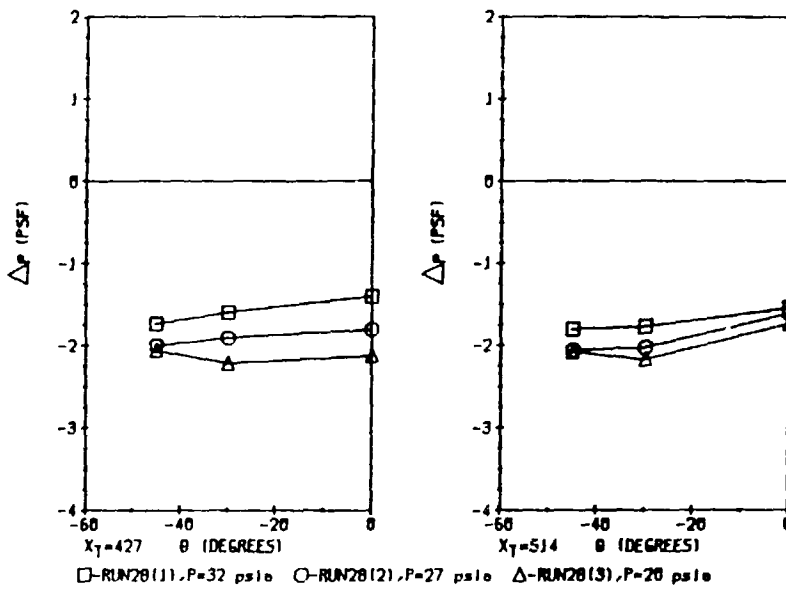
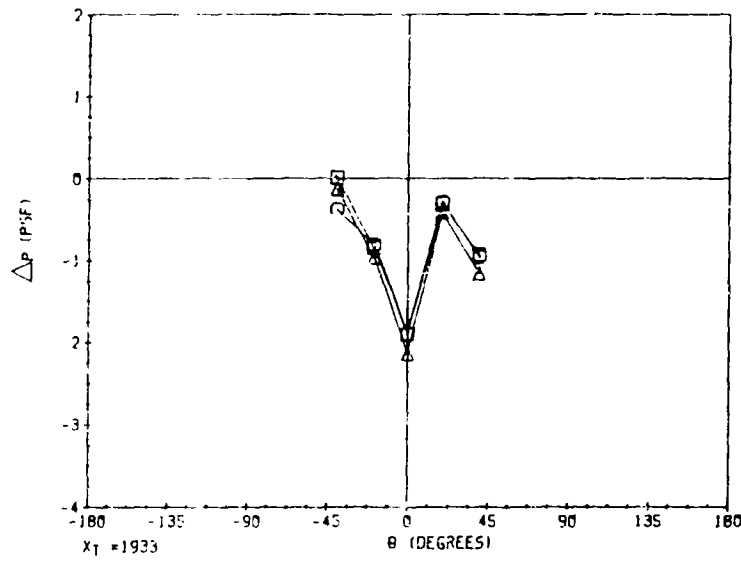
$\beta = 338^\circ$

$\phi = 0$

ORIGINAL PAGE IS
OF POOR QUALITY







ORIGINAL PAGE IS
OF POOR QUALITY

VARIABLE NOZZLE SIZE CONFIGURATION

GROUP XI

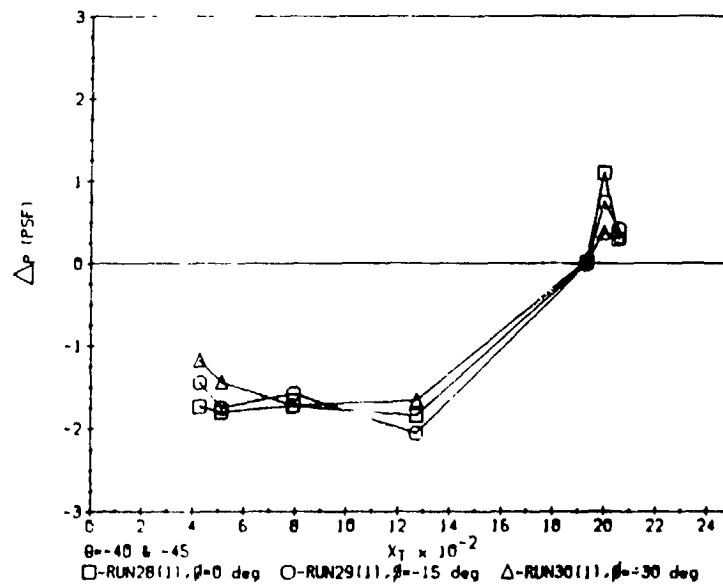
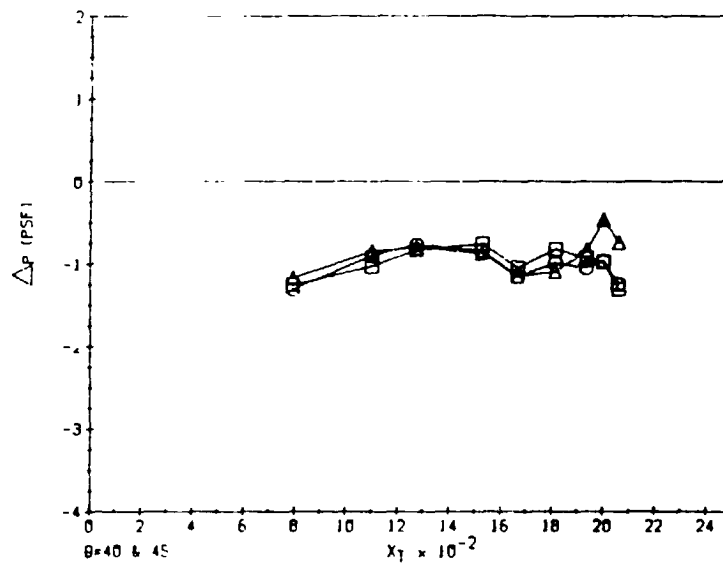
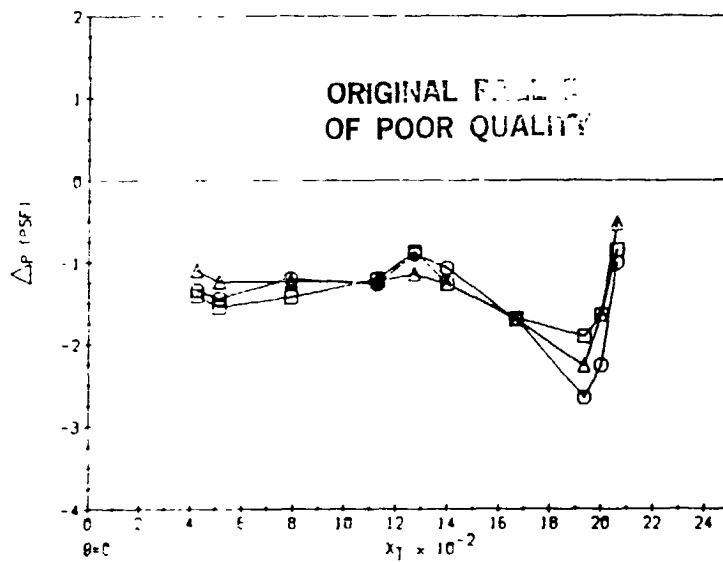
NOZZLE AZIMUTH ANGLE EFFECTS

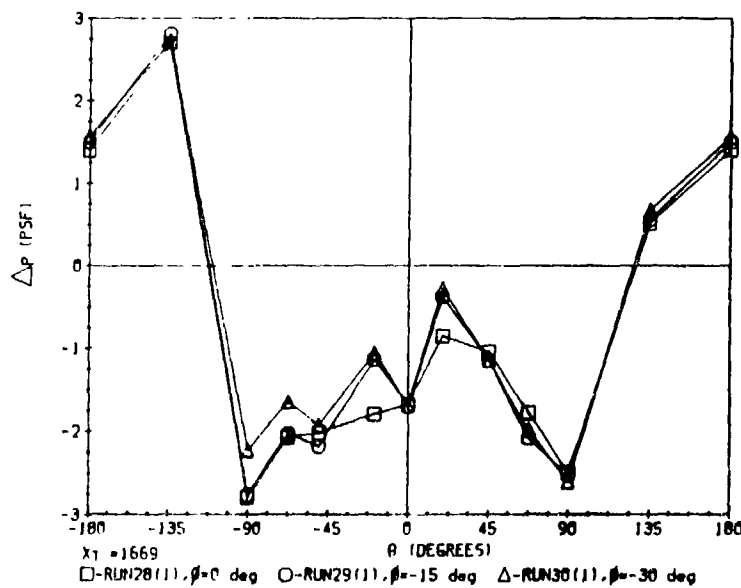
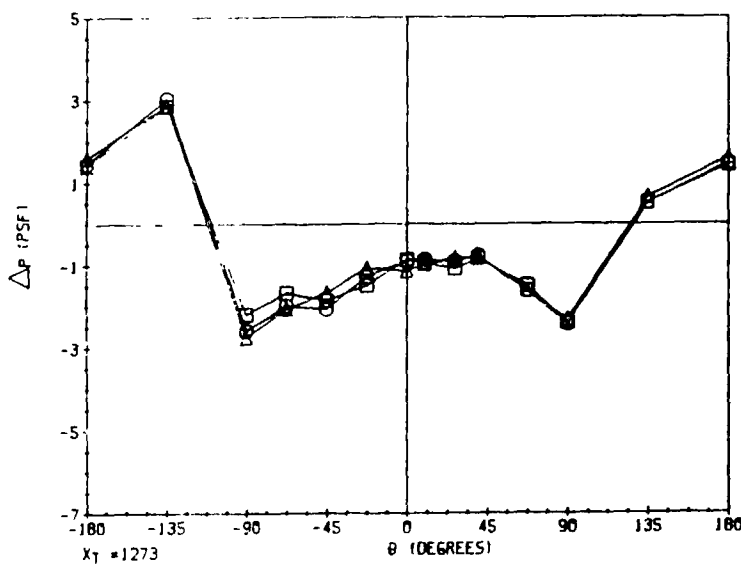
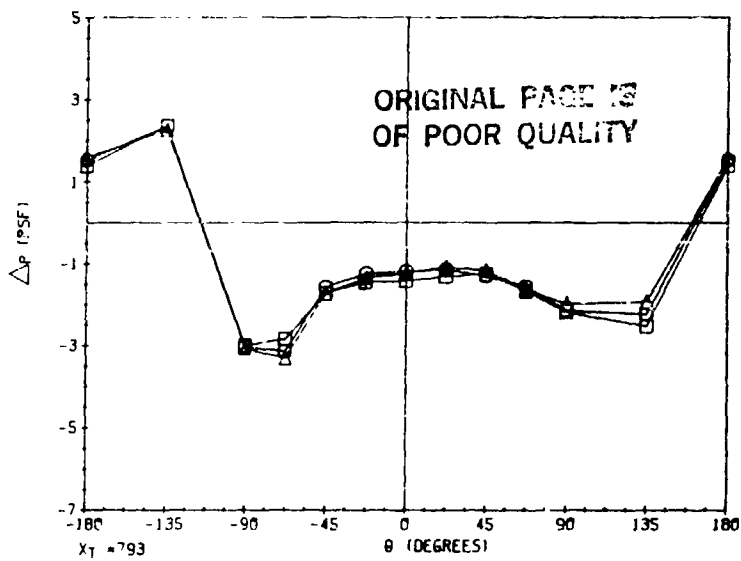
RUNS 28.1, 29.1 and 30.1

$P = 32 \text{ psia}$

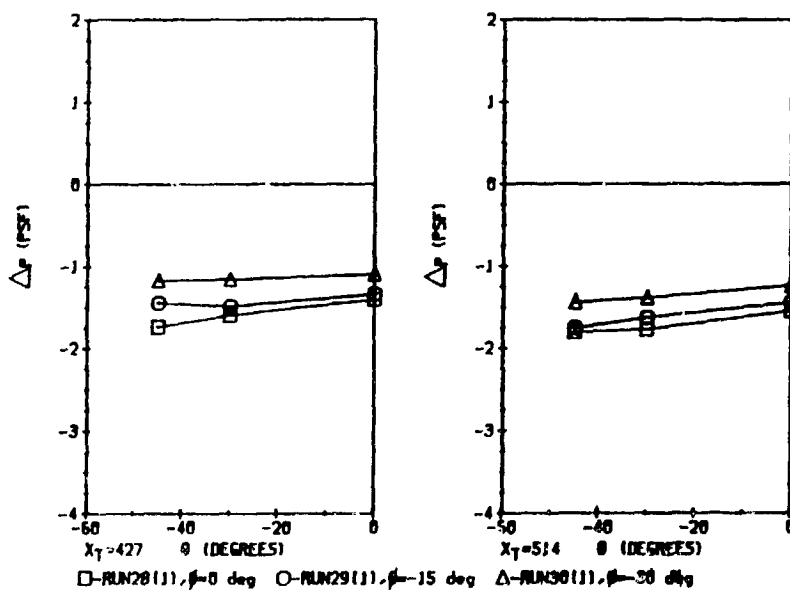
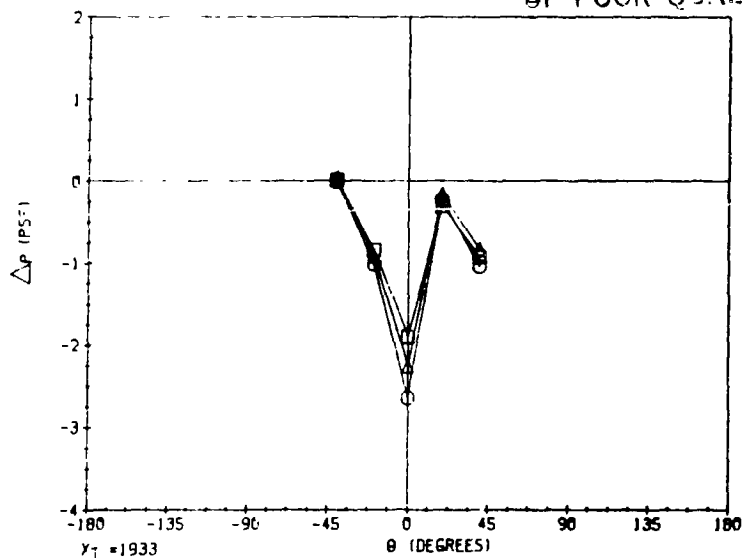
$V = 20 \text{ KNOTS}$

$\beta = 338^\circ$





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OF POOR QUALITY

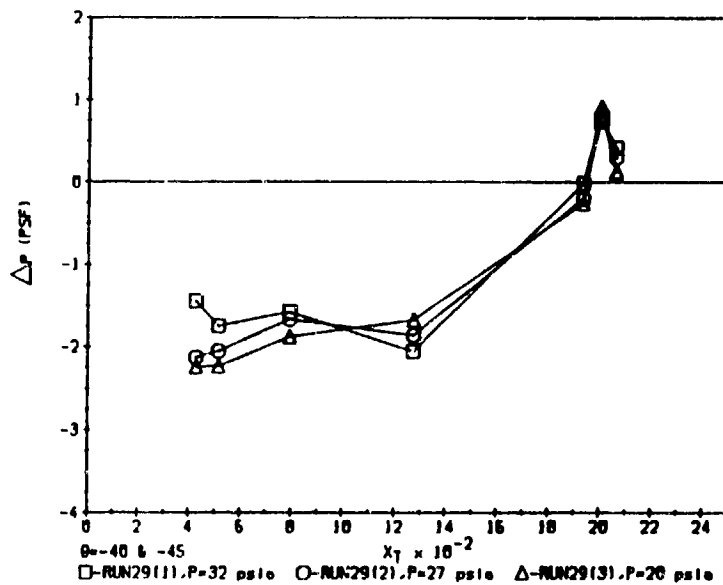
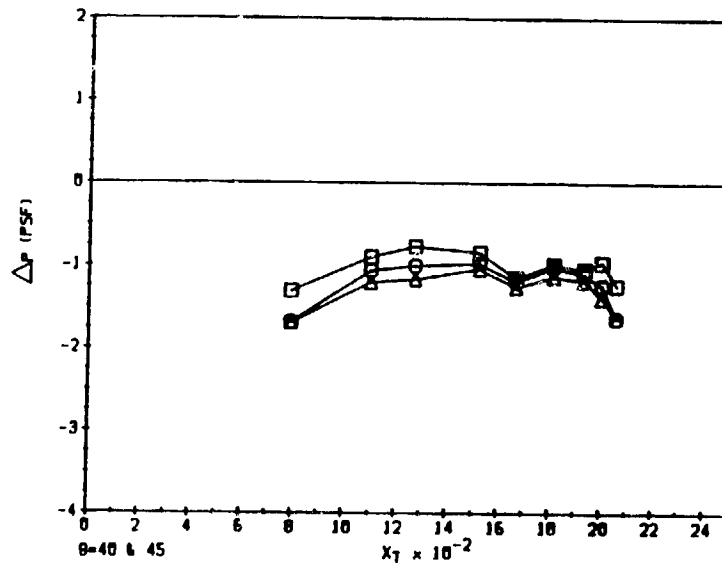
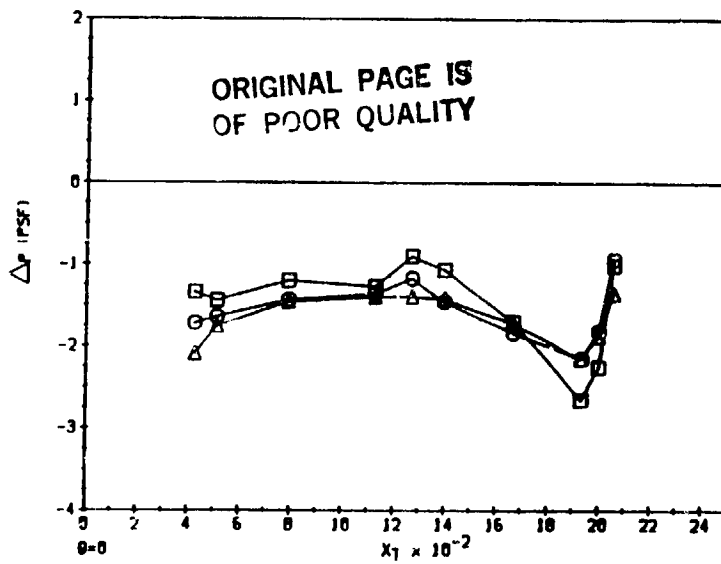


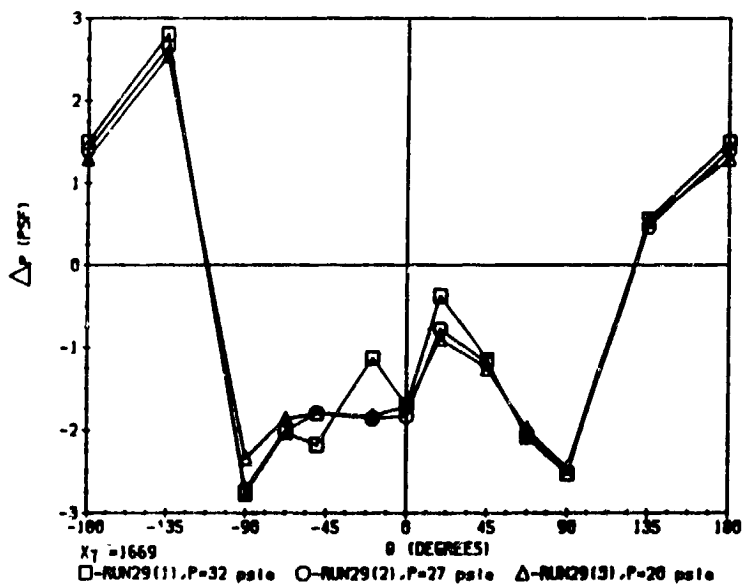
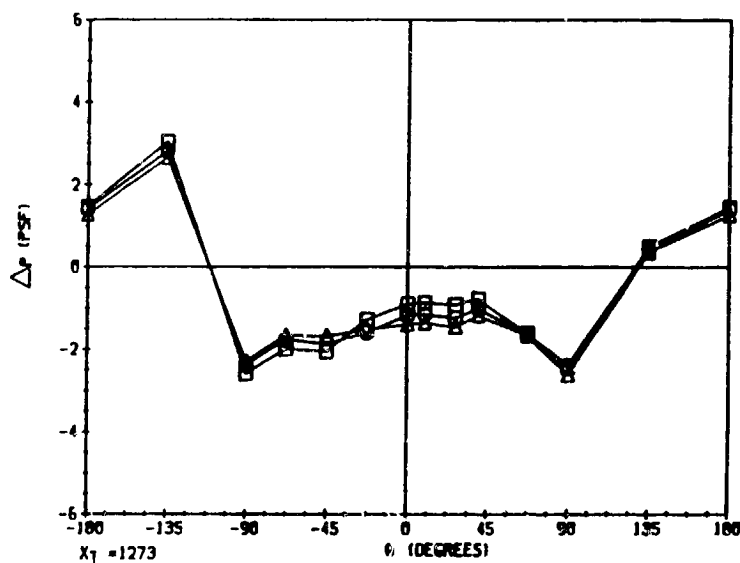
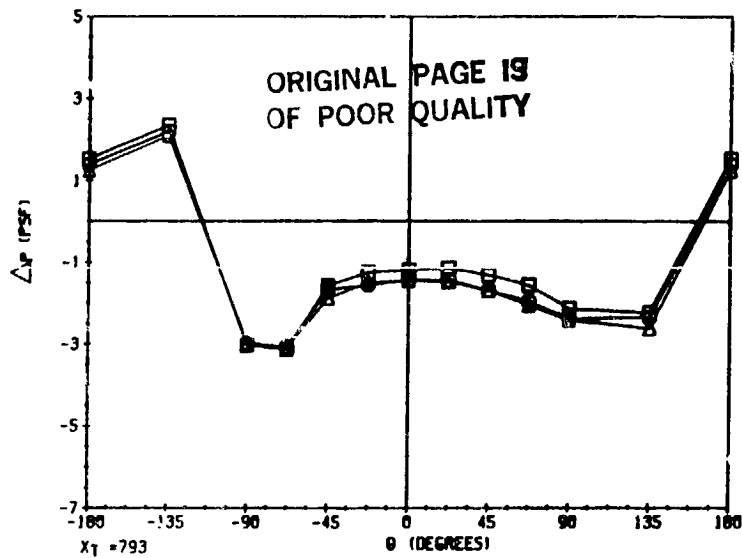
VARIABLE NOZZLE SIZE CONFIGURATION
GROUP XII
INFLUENCE OF NOZZLE PRESSURE ON WIND PENETRATION
FOR A -15° NOZZLE AZIMUTH ANGLE
RUNS 29.1, 29.2 and 29.3

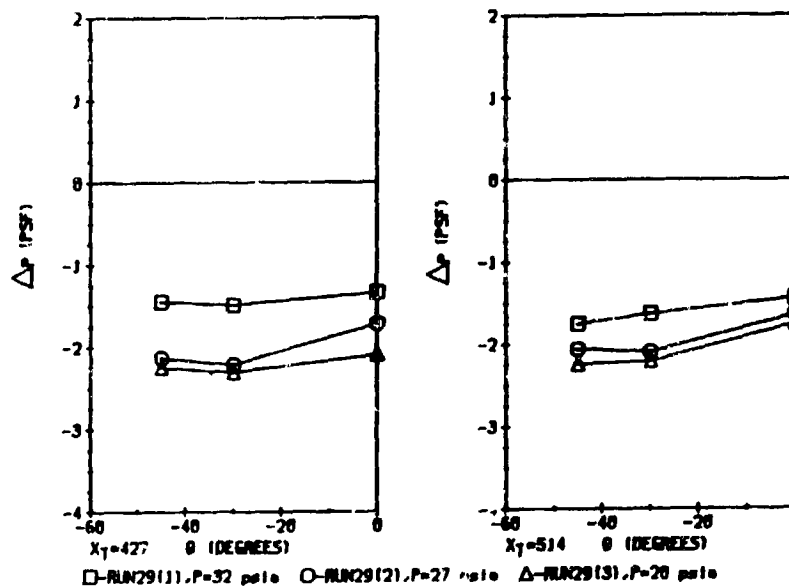
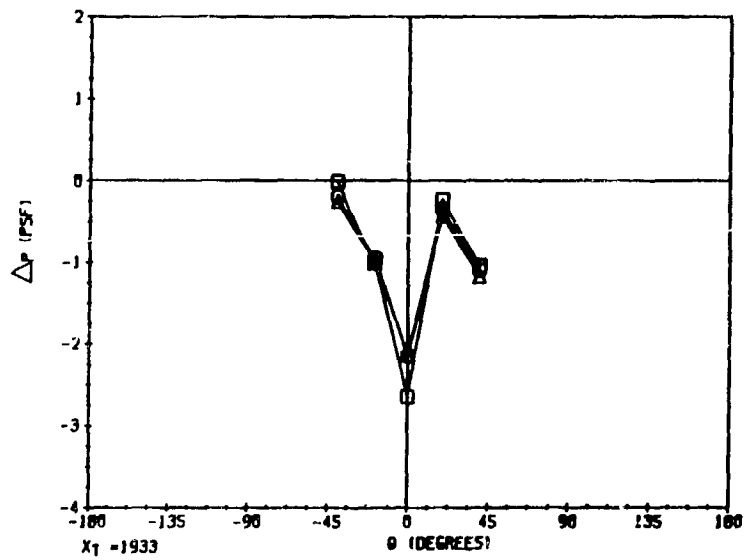
$V = 20$ KNOTS

$\beta = 338^\circ$

$\phi = -15^\circ$







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OF POOR QUALITY



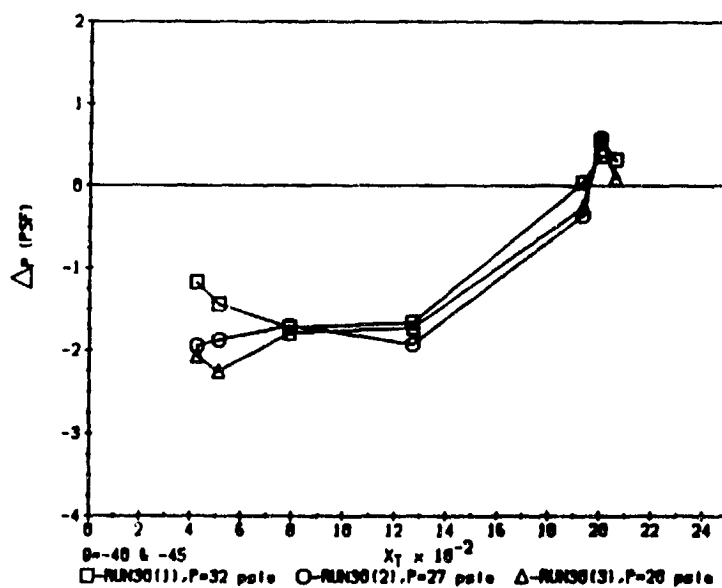
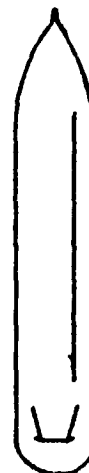
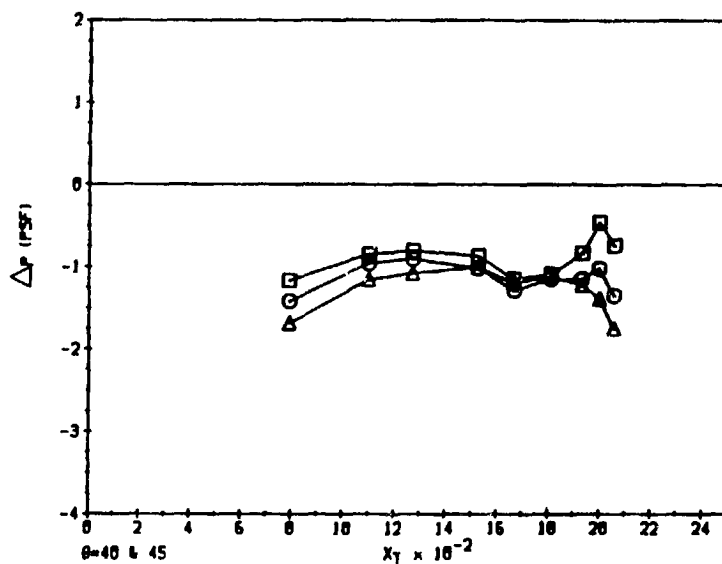
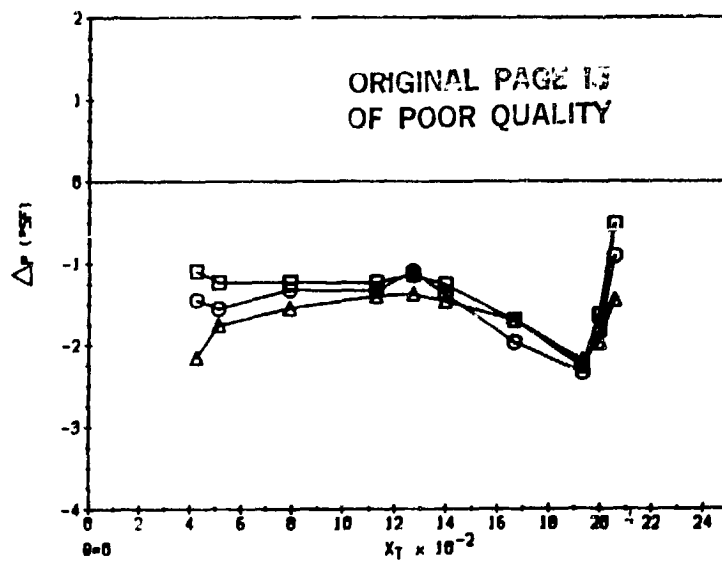
VARIABLE NOZZLE SIZE CONFIGURATION
GROUP XIII
INFLUENCE OF NOZZLE PRESSURE ON WIND PENETRATION
FOR A -30° NOZZLE AZIMUTH ANGLE
RUNS 30.1, 30.2 and 30.3

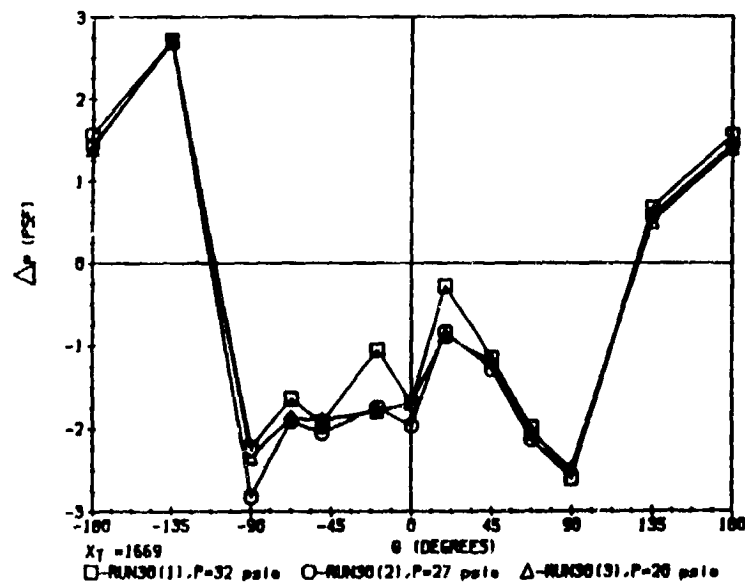
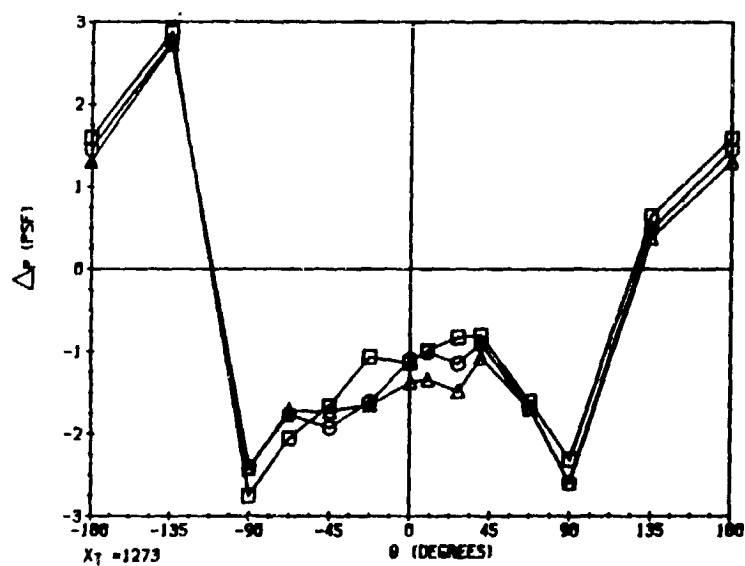
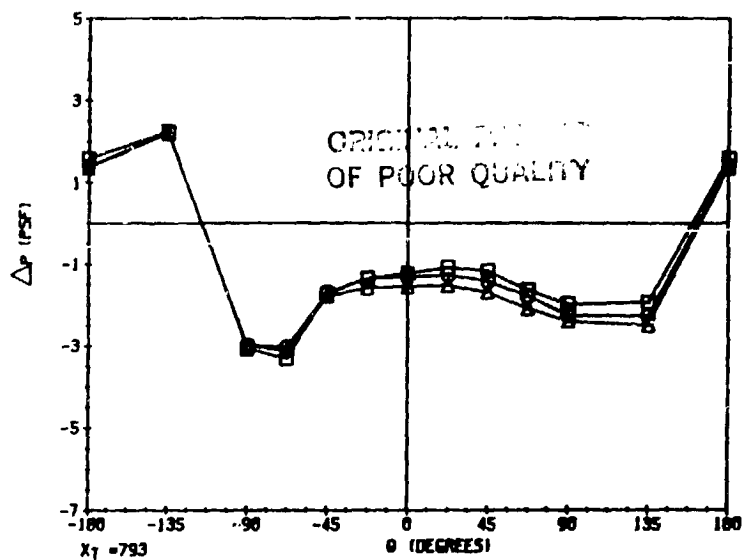
$V = 20$ KNOTS

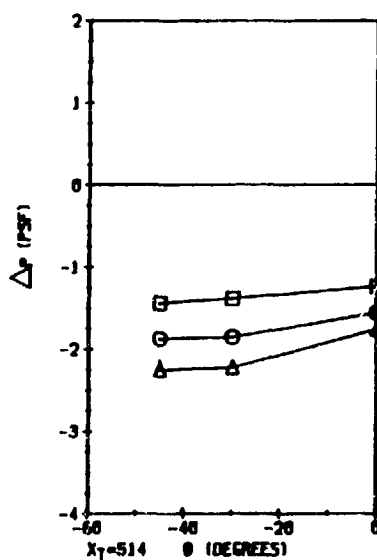
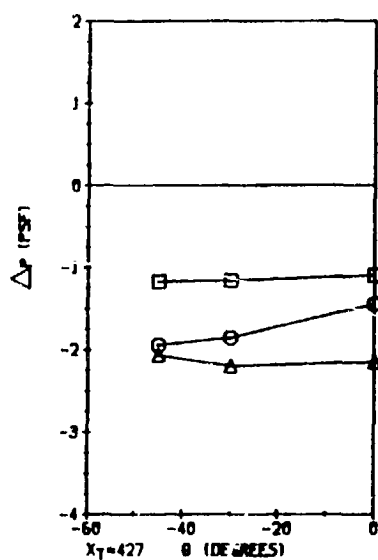
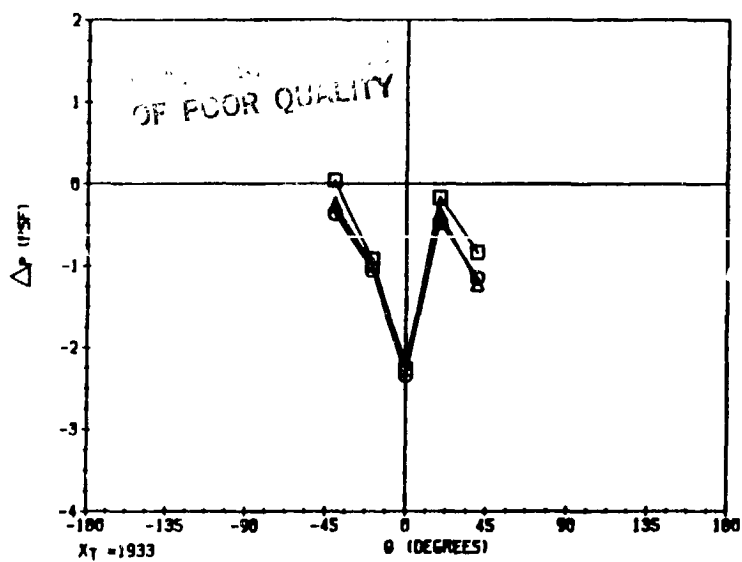
$\beta = 338^\circ$

$\phi = -30^\circ$









□-RUN30(1), P=32 psia ○-RUN30(2), P=27 psia △-RUN30(3), P=26 psia

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

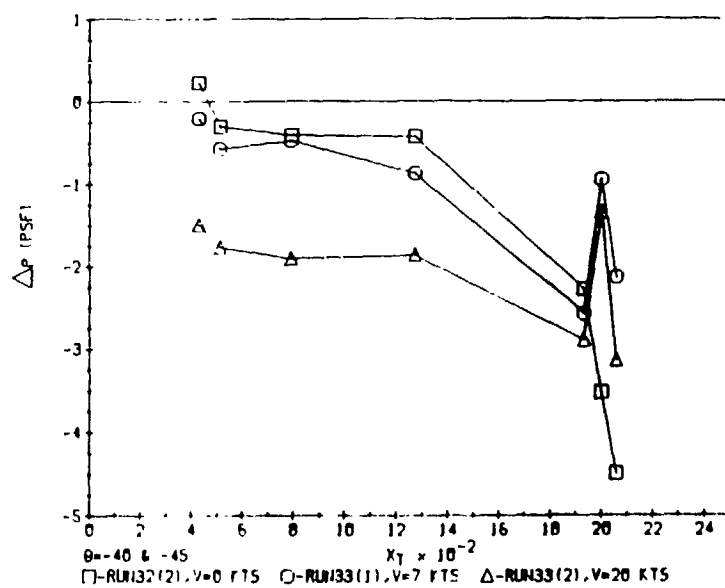
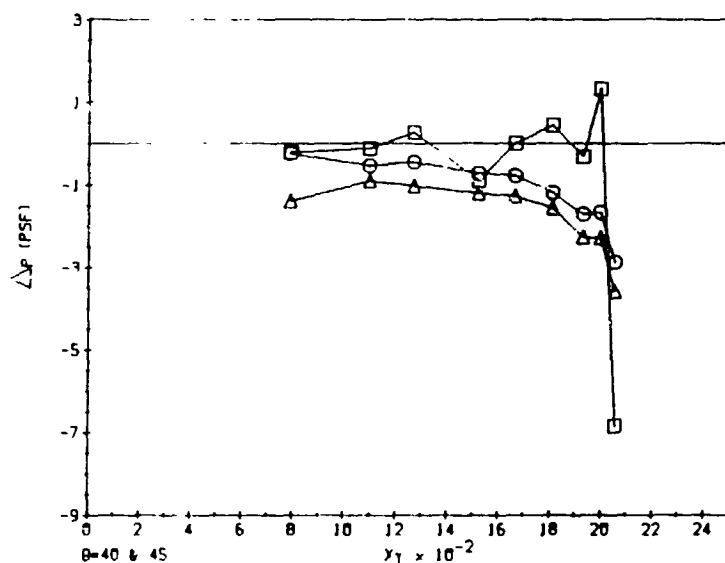
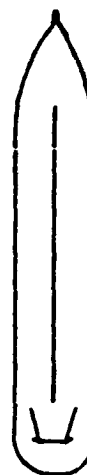
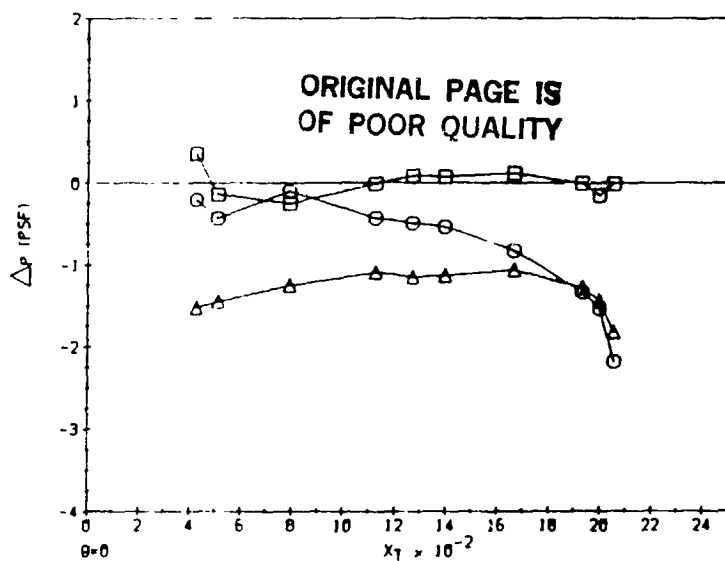
GROUP XIV

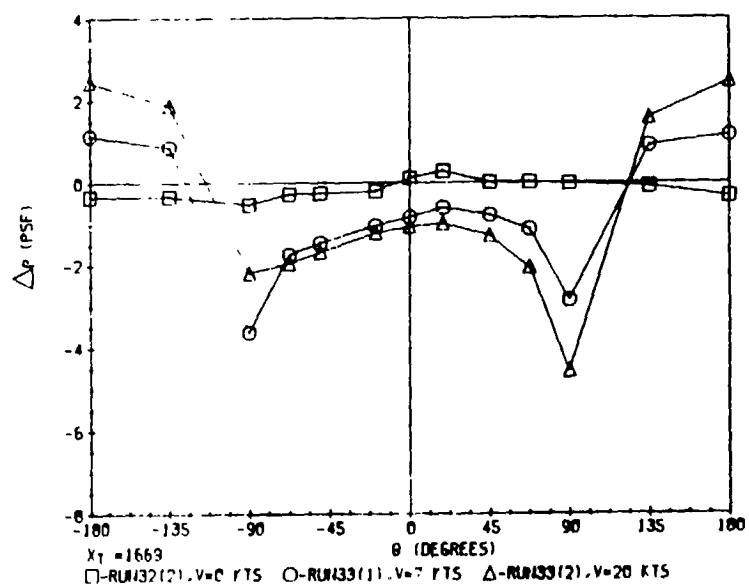
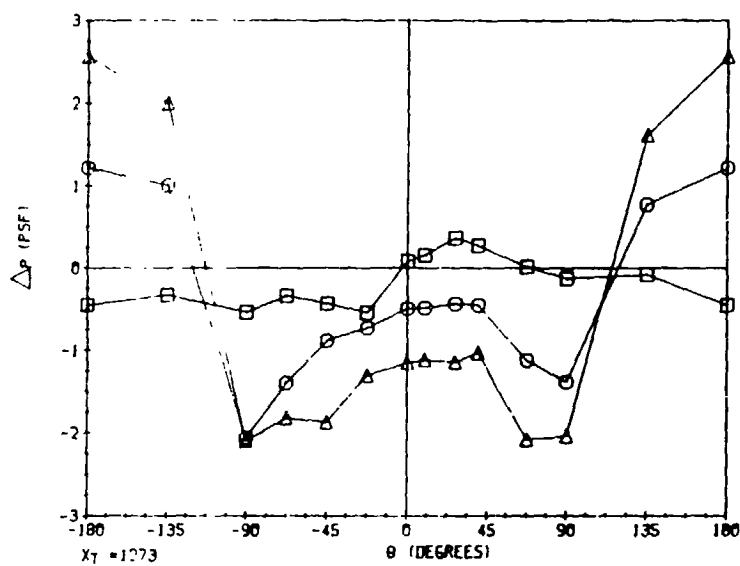
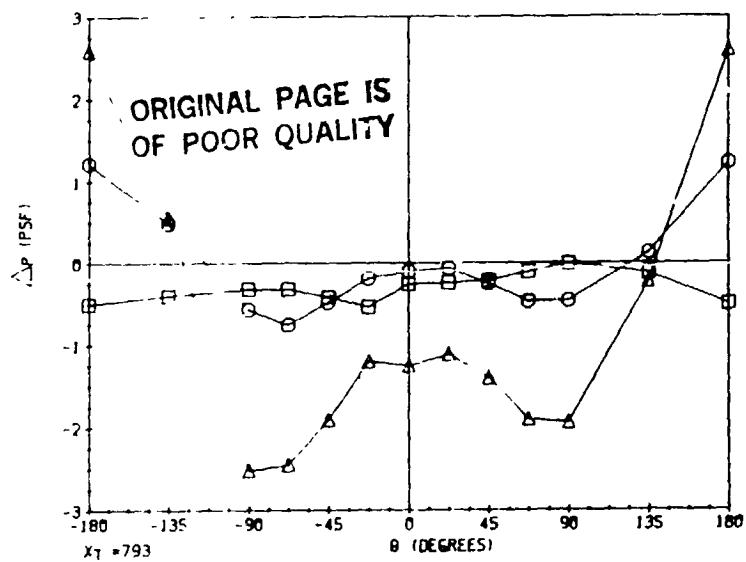
WIND VELOCITY EFFECTS AT 0°, LOW FLOWRATE

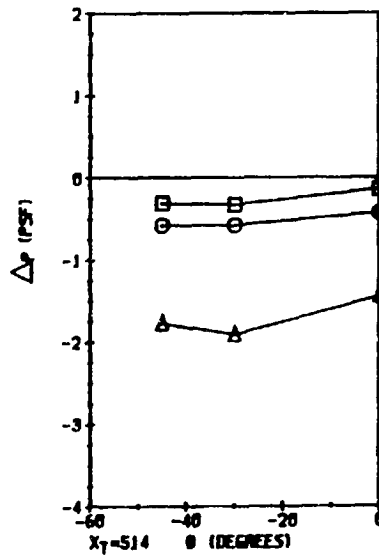
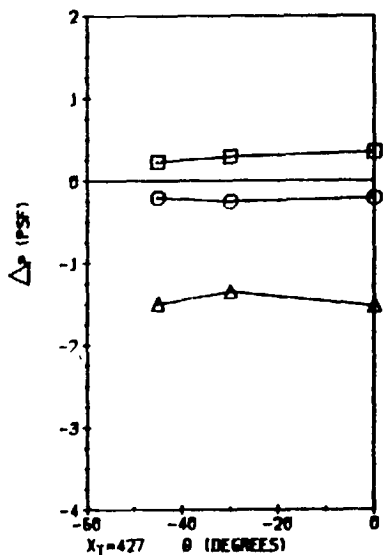
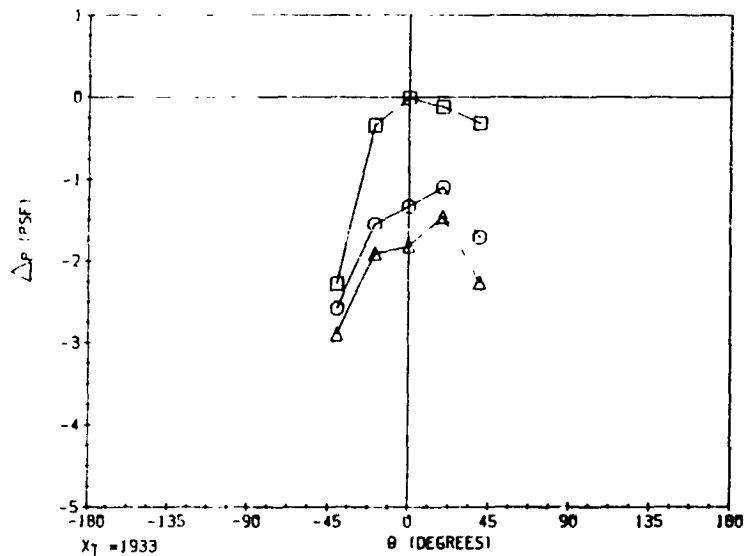
RUNS 33.1 and 33.2

$\beta = 0^\circ$

Low Flowrate







□-RUN32(2), V=0 KTS ○-RUN33(1), V=7 KTS △-RUN33(2), V=20 KTS

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OF POOR QUALITY

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

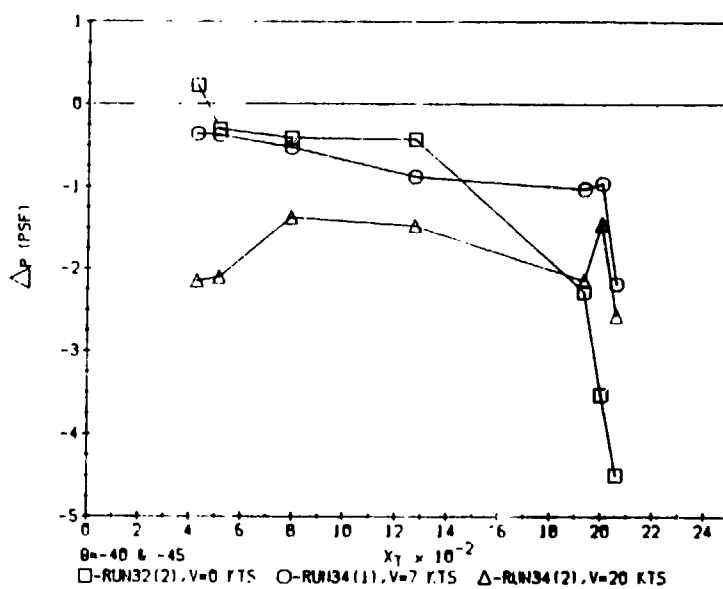
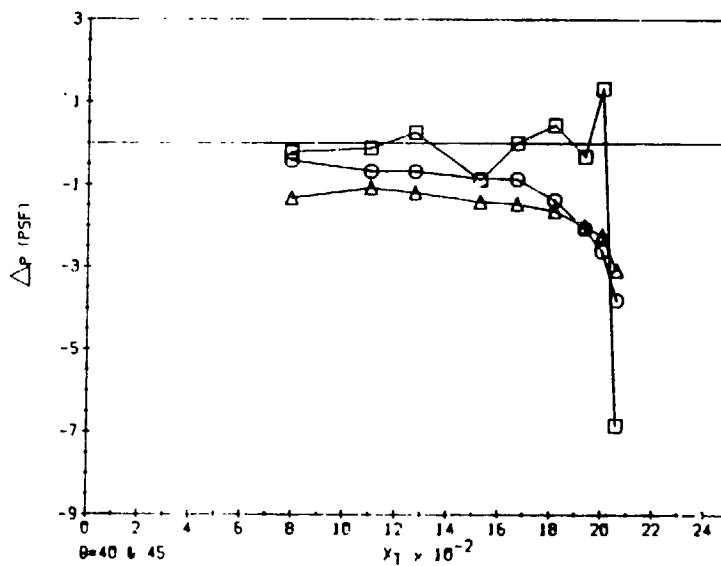
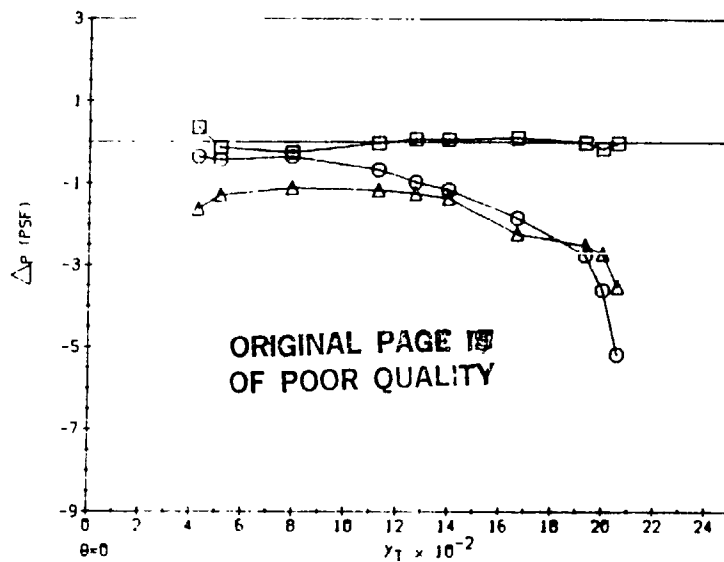
GROUP XV

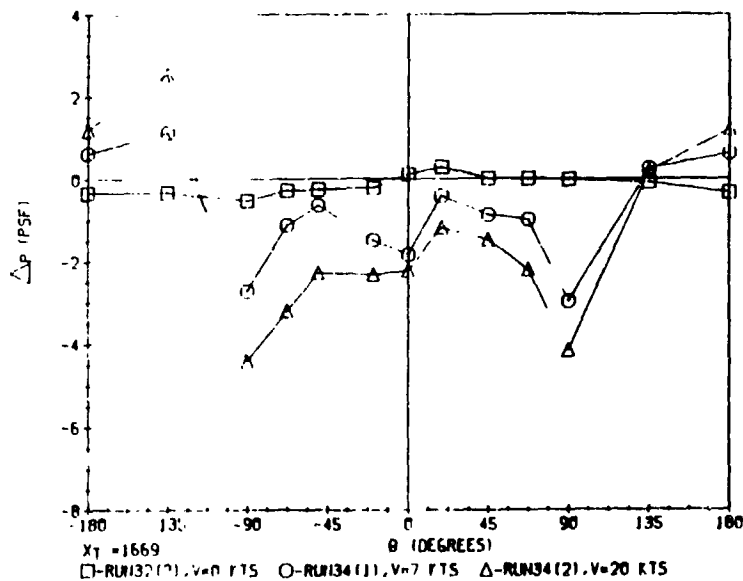
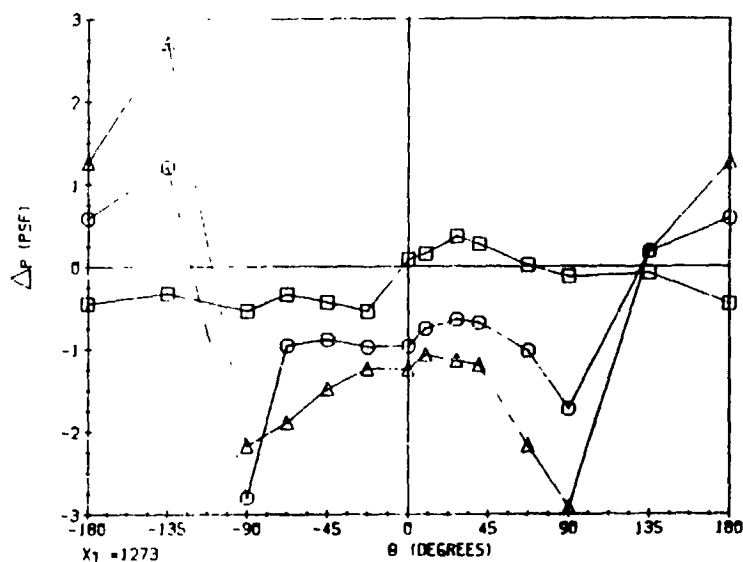
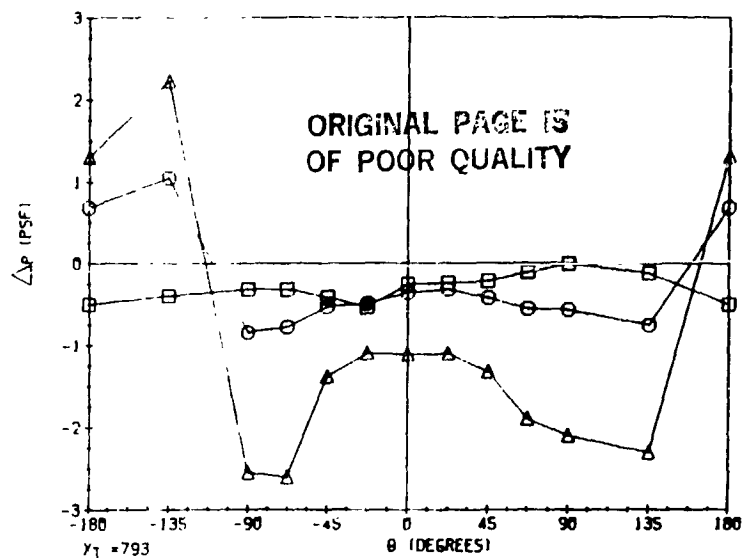
WIND VELOCITY EFFECTS AT 338°, LOW FLOWRATE

RUNS 34.1 and 34.2

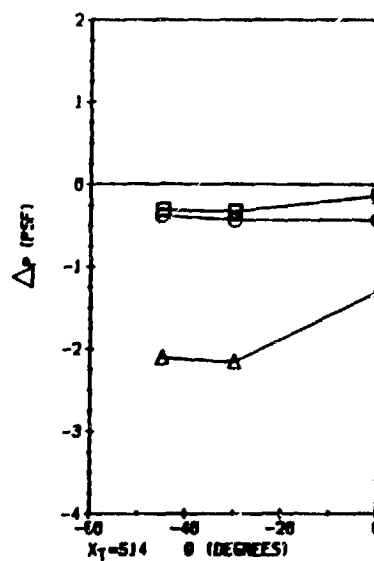
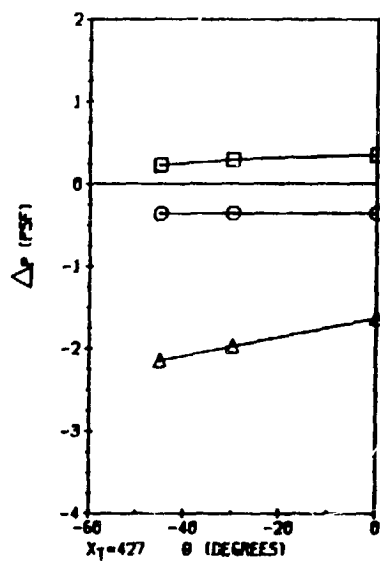
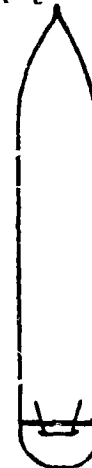
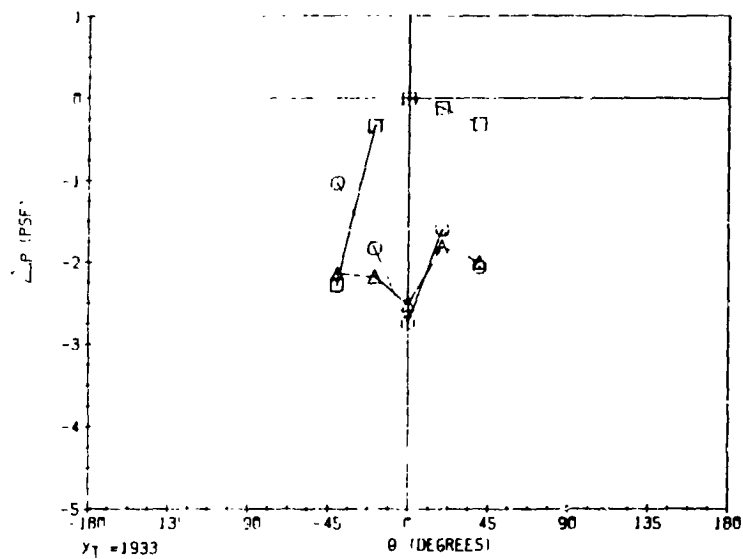
$\beta = 338^\circ$

Low Flowrate





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OF POOR QUALITY



\square -RUN32(2), V=6 KTS \circ -RUN34(1), V=7 KTS Δ -RUN34(2), V=20 KTS

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

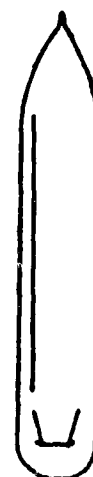
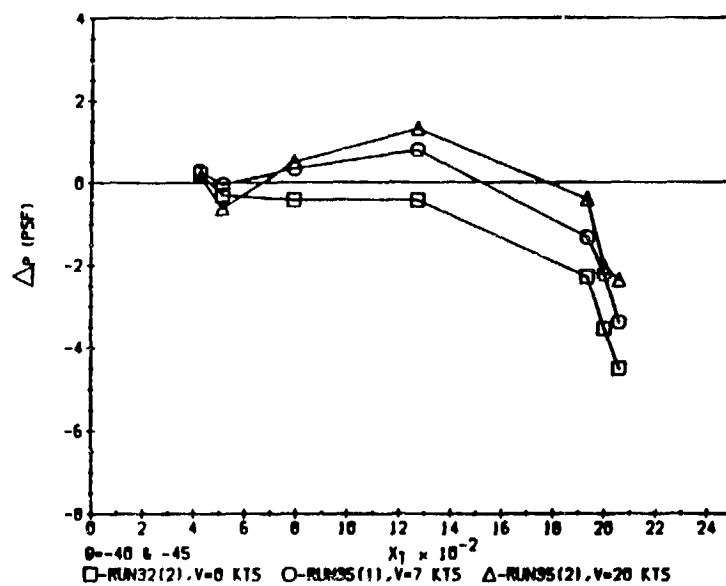
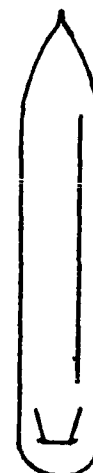
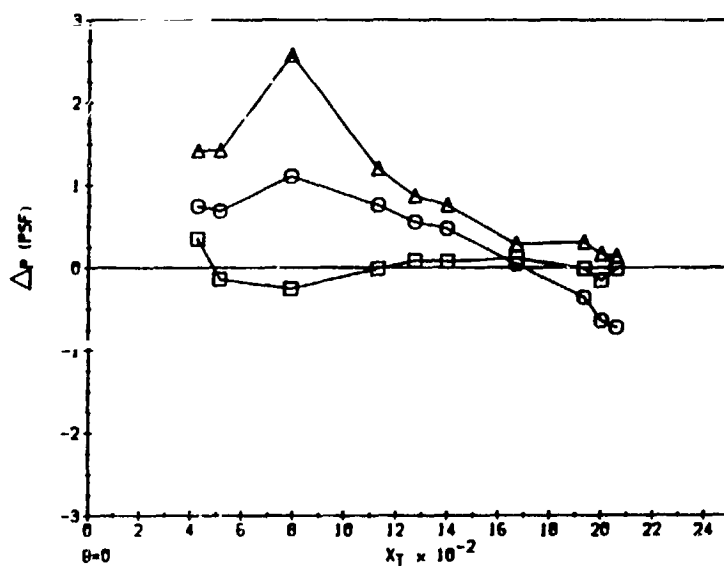
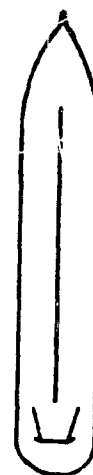
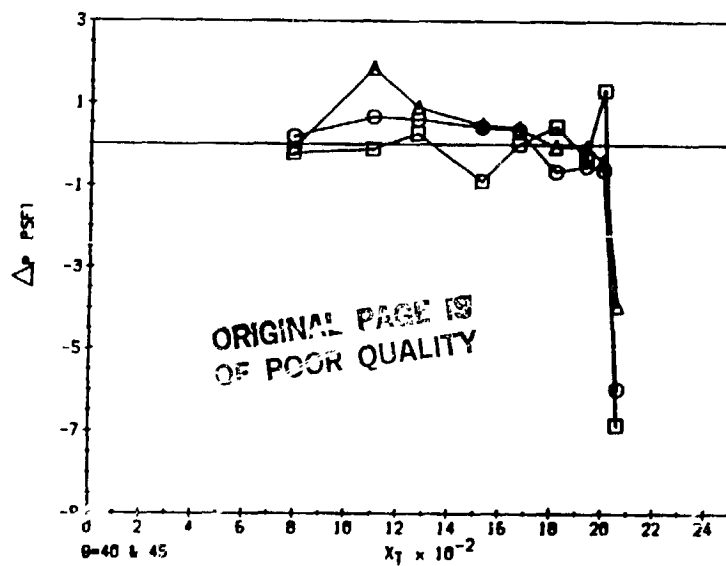
GROUP XVI

WIND VELOCITY EFFECTS AT 180°, LOW FLOWRATE

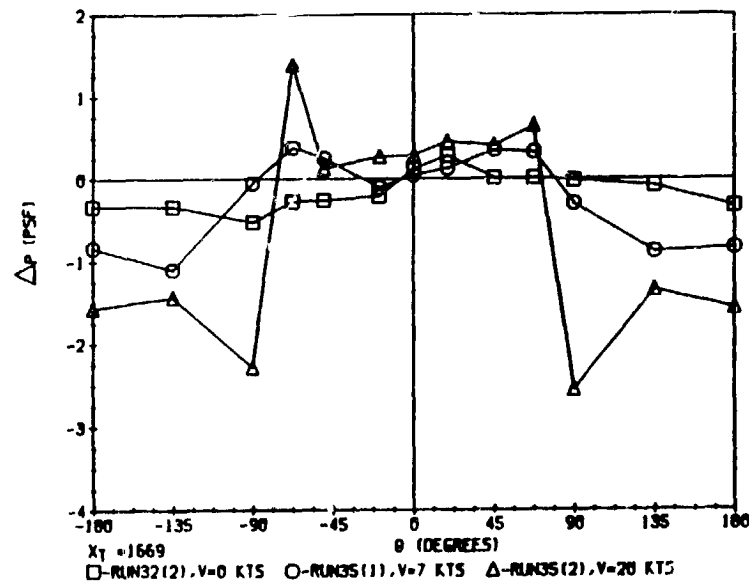
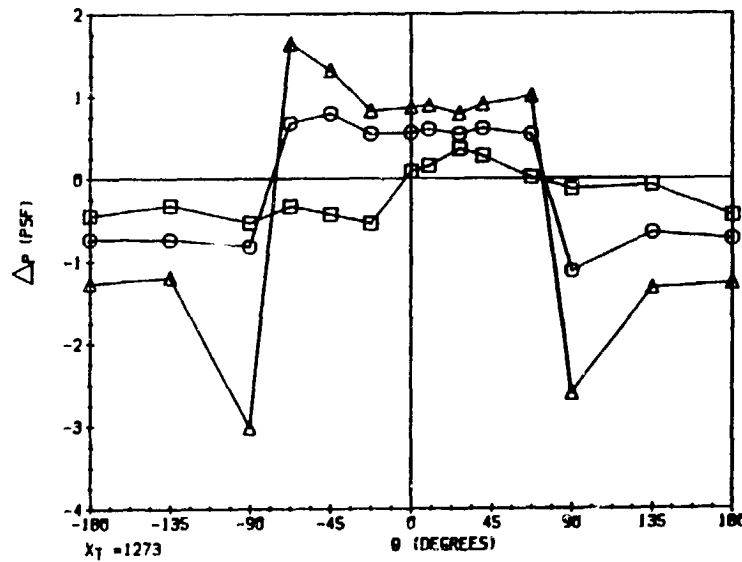
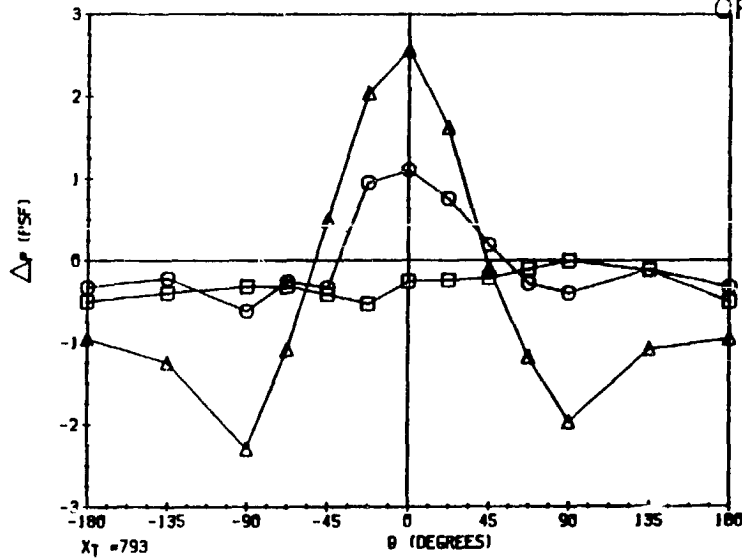
RUNS 35.1 and 35.2

$\beta = 180^\circ$

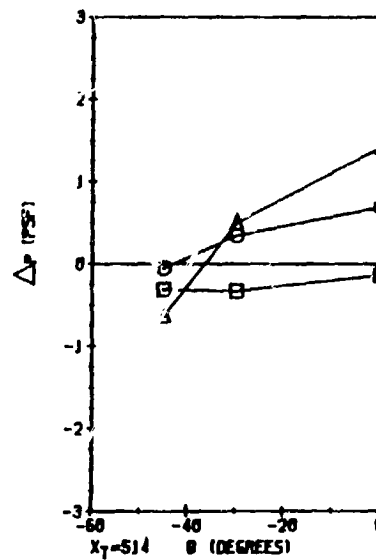
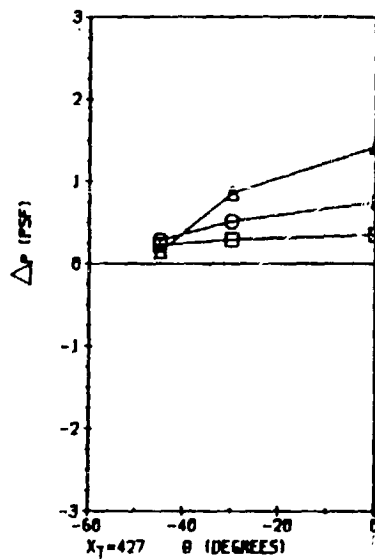
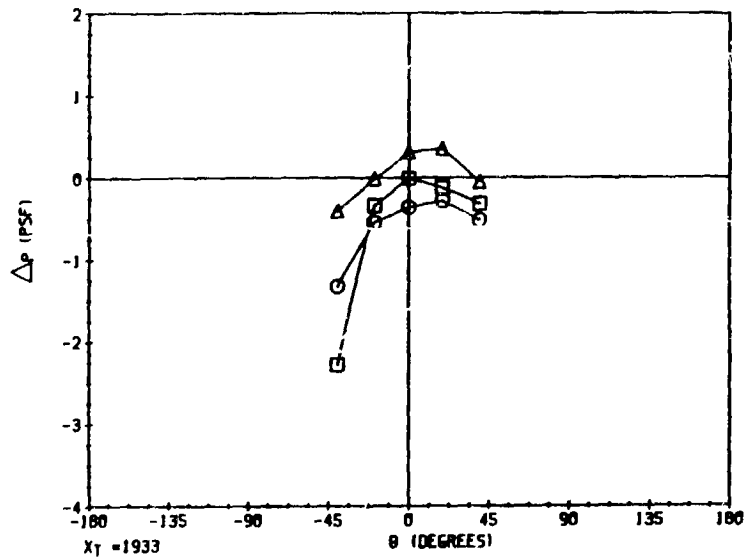
Low Flowrate



ORIGIN OF COORDINATES
OF POOR QUALITY



ORIGINAL PAGE IS
OF POOR QUALITY



□-RUN32(2), V=0 KTS ○-RUN35(1), V=7 KTS △-RUN35(2), V=20 KTS

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

GROUP XVII

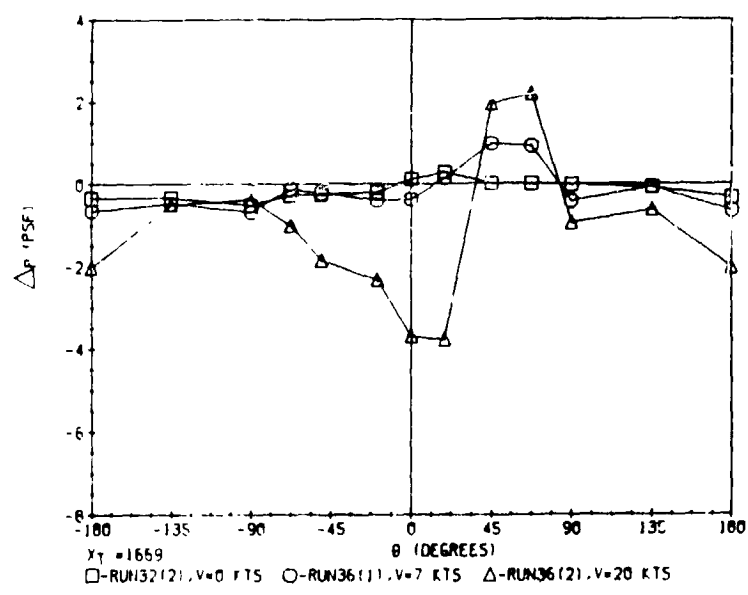
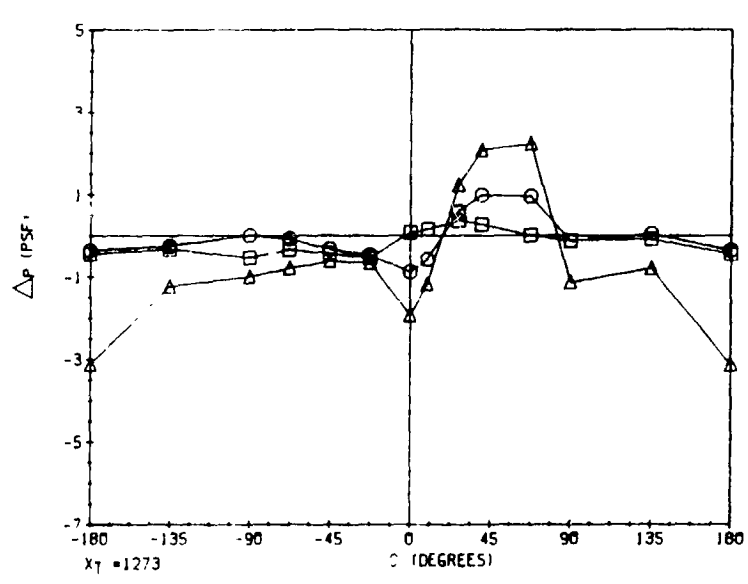
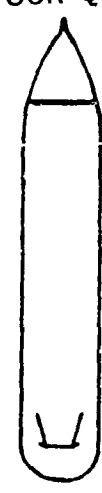
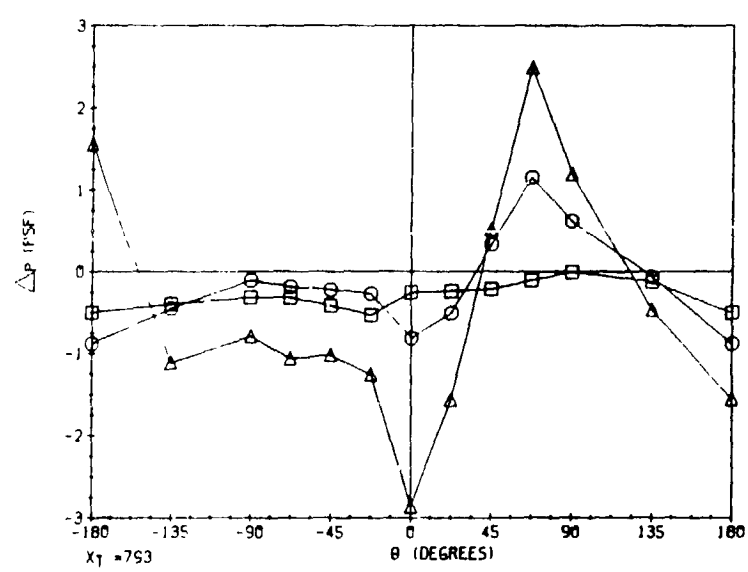
WIND VELOCITY EFFECTS AT 90°, LOW FLOWRATE

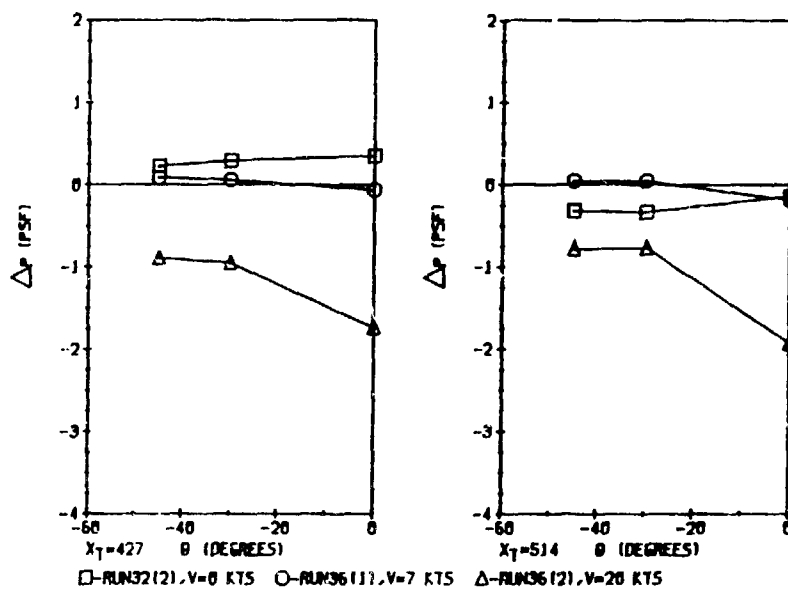
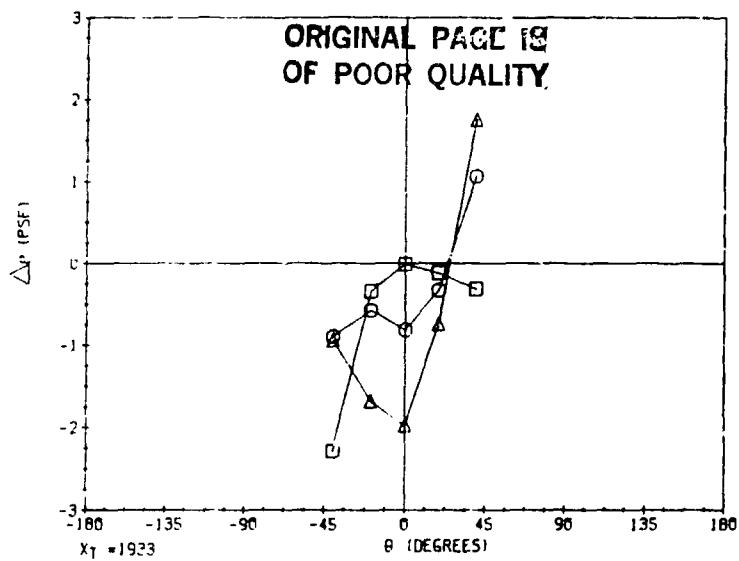
RUNS 36.1 and 36.2

$\beta = 90^\circ$

Low Flowrate

ORIGINAL PAGE 13
OF POOR QUALITY

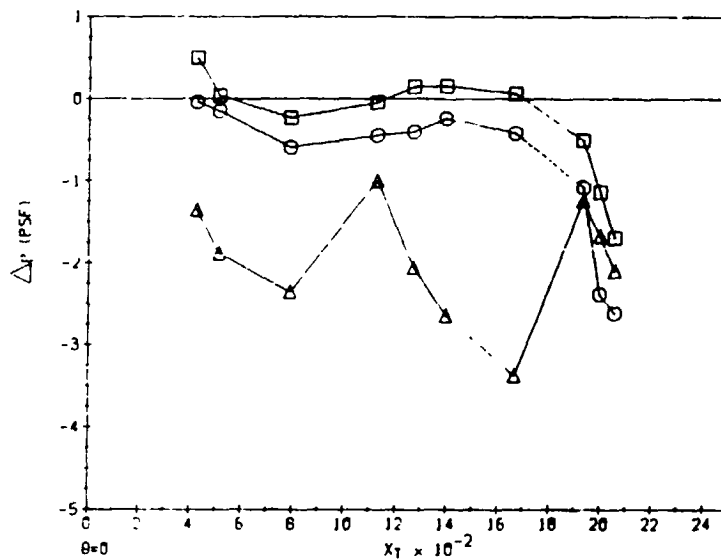




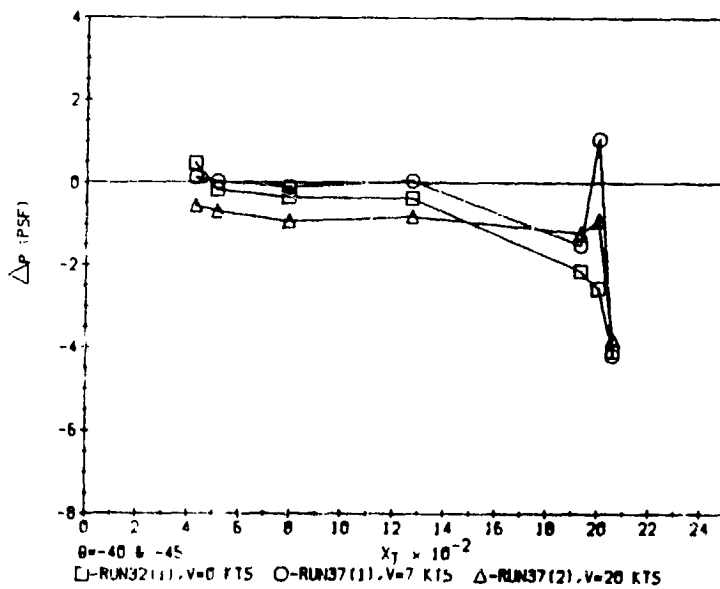
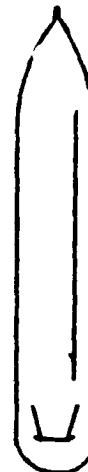
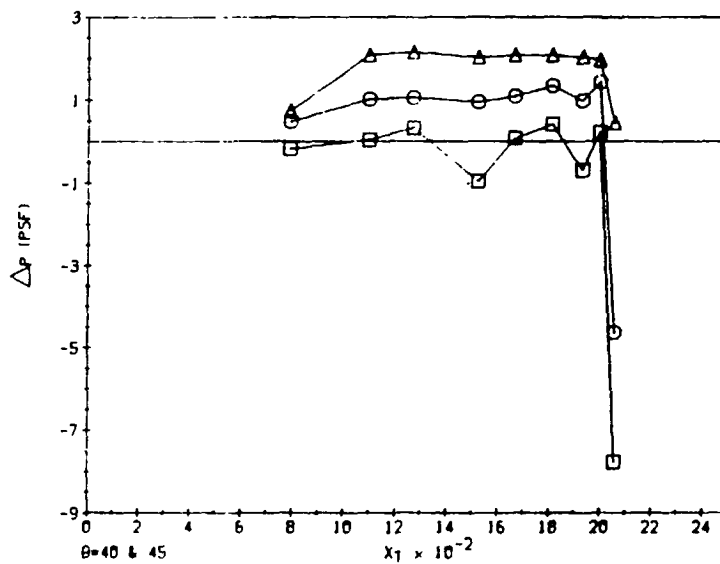
MARSHALL SPACE FLIGHT CENTER CONFIGURATION
GROUP XVIII
WIND VELOCITY EFFECTS AT 90°, HIGH FLOWRATE
RUNS 37.1 and 37.2

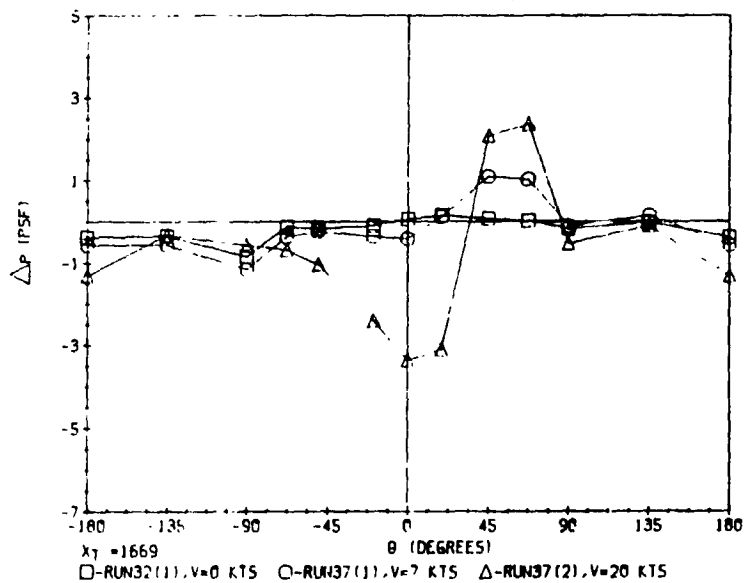
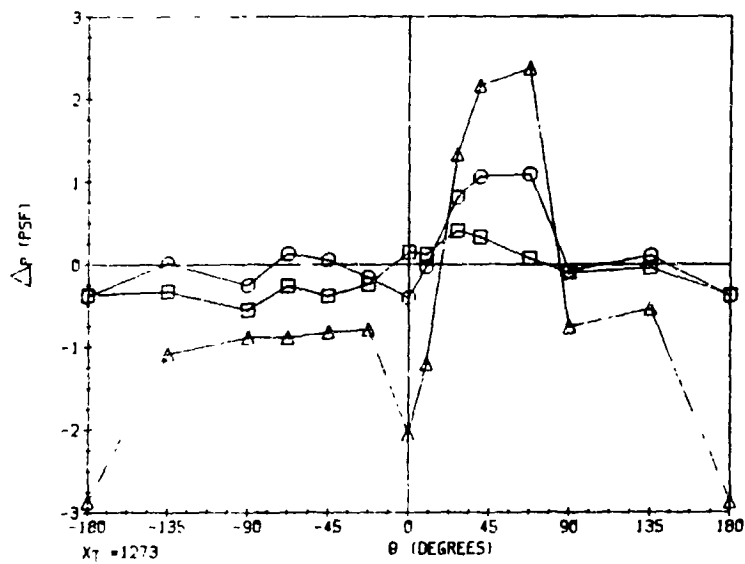
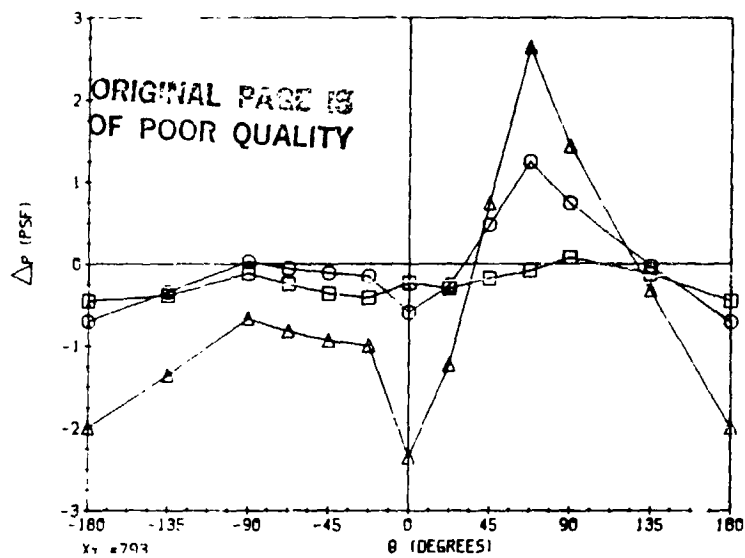
$\beta = 90^\circ$

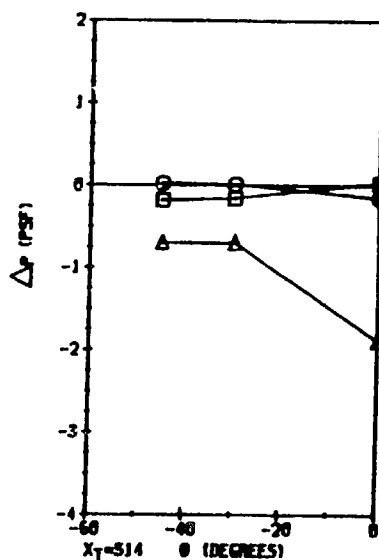
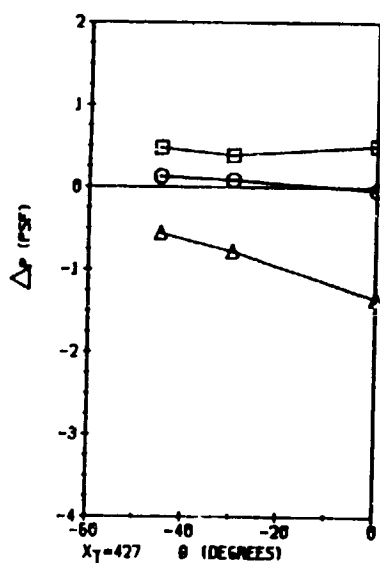
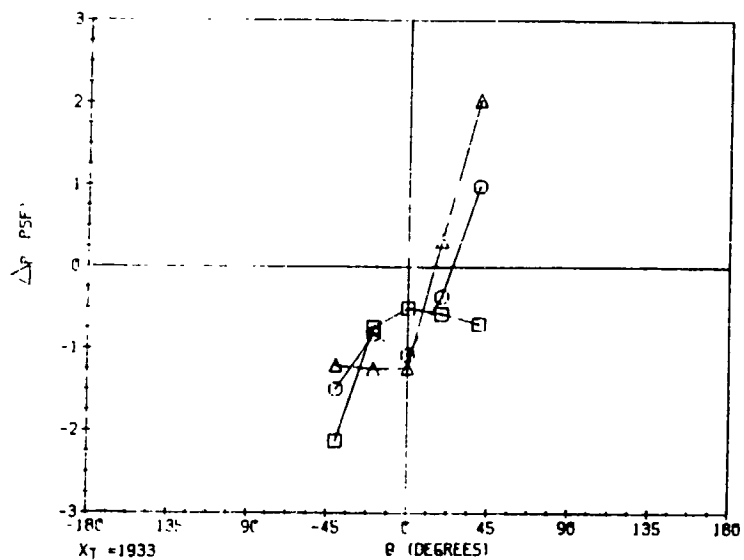
High Flowrate



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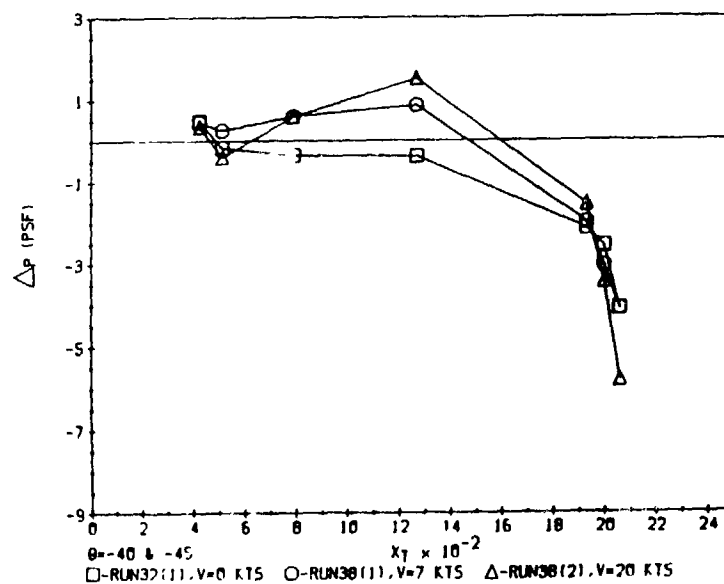
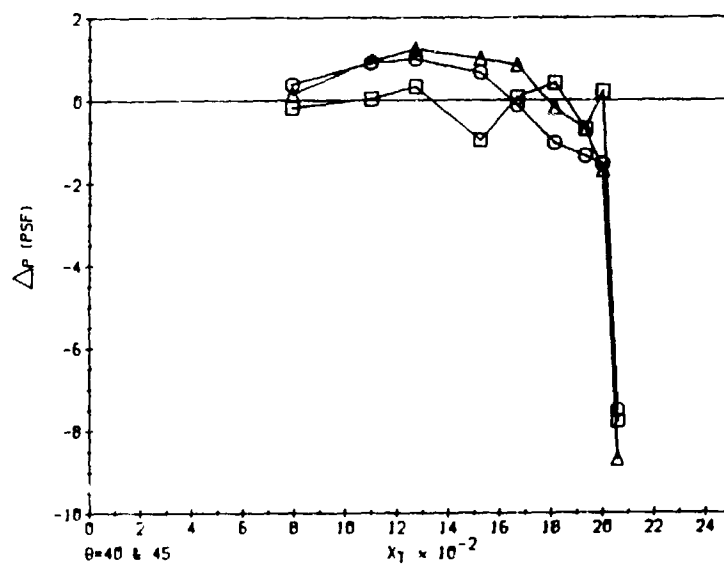
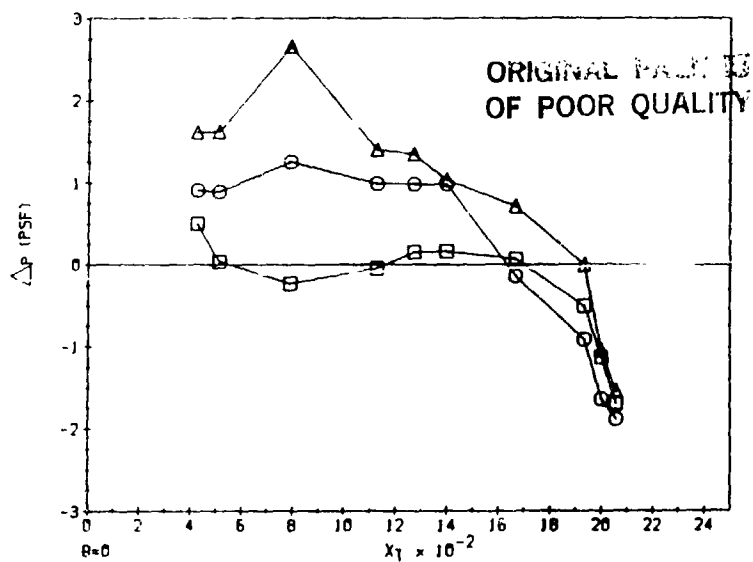
□-RUN32(1), V=0 KTS ○-RUN37(1), V=7 KTS △-RUN37(2), V=20 KTS

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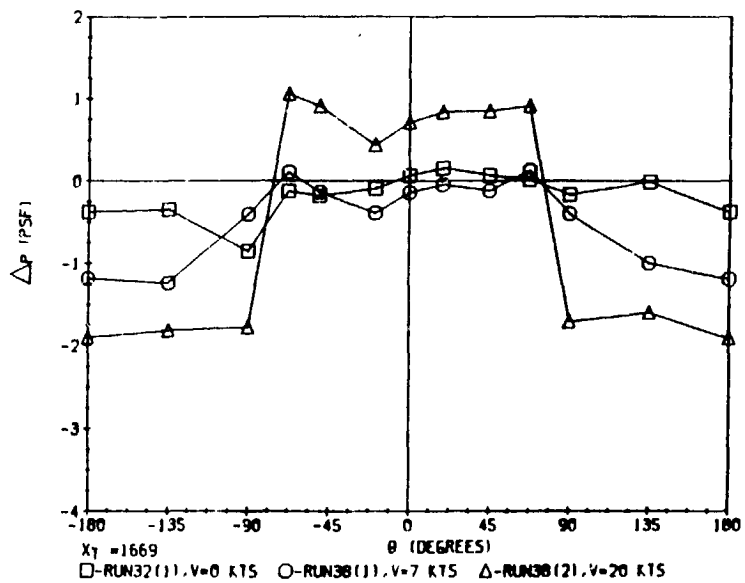
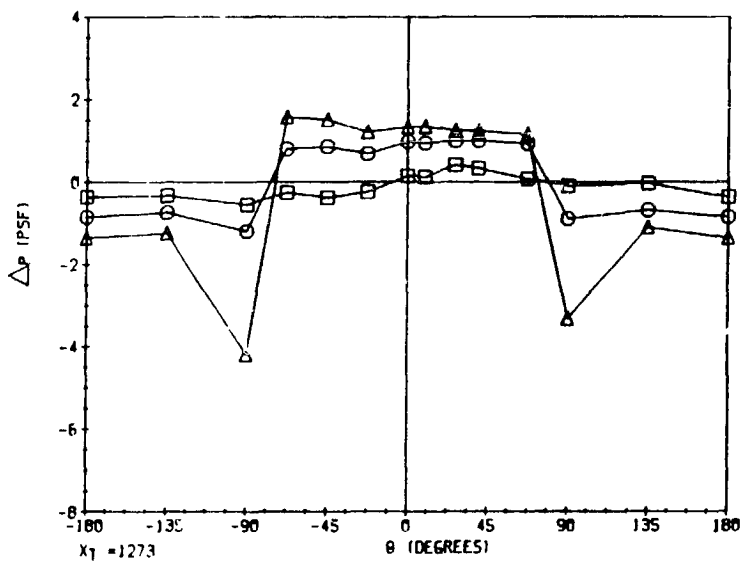
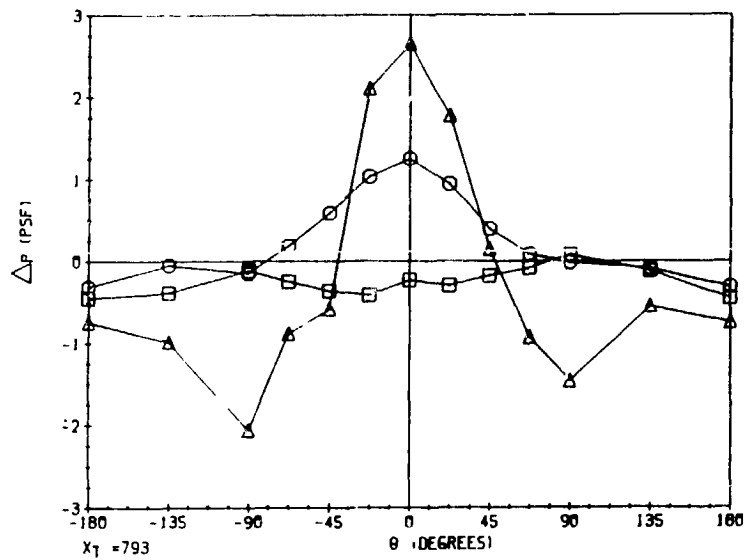
MARSHALL SPACE FLIGHT CENTER CONFIGURATION
GROUP XIX
WIND VELOCITY EFFECTS AT 180°, HIGH FLOWRATE
RUNS 38.1 and 38.2

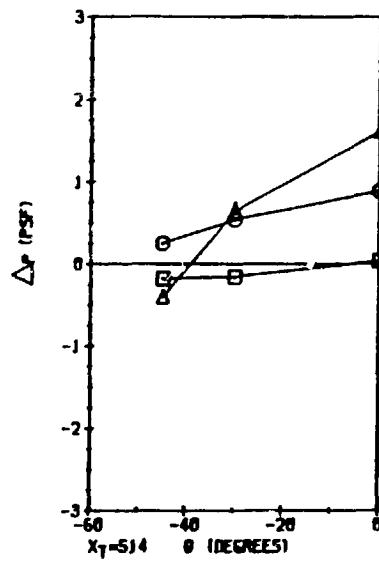
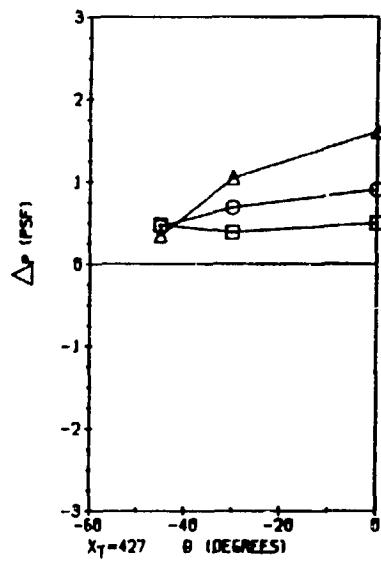
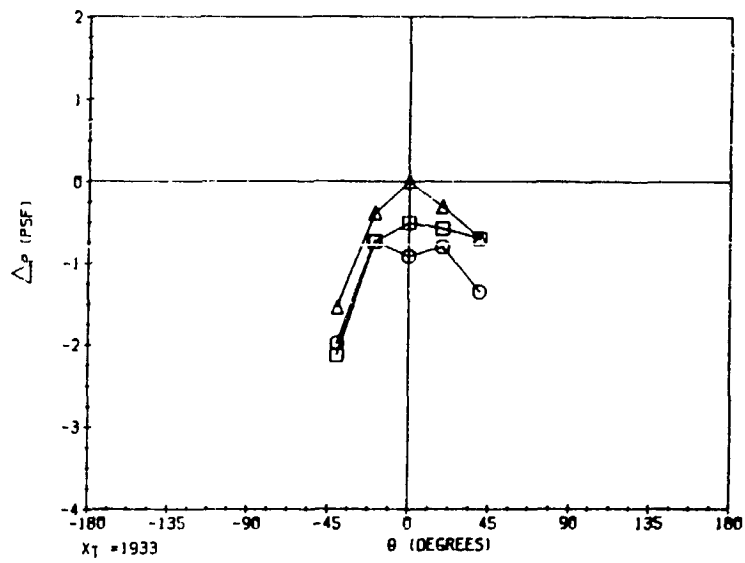
$\beta = 180^\circ$

High Flowrate



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□-RUN32(1), V=0 KTS ○-RUN30(1), V=7 KTS △-RUN30(2), V=20 KTS

ORIGINAL FIGURE
OF POOR QUALITY

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

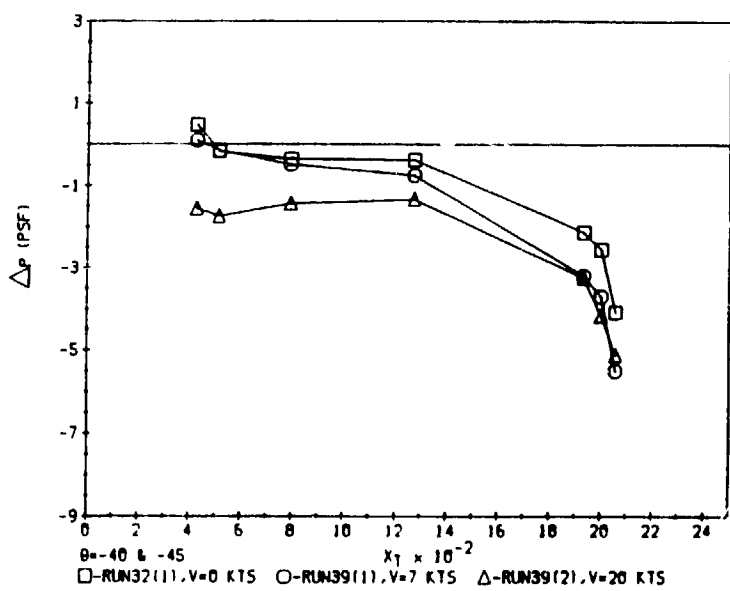
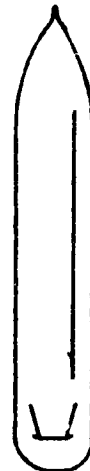
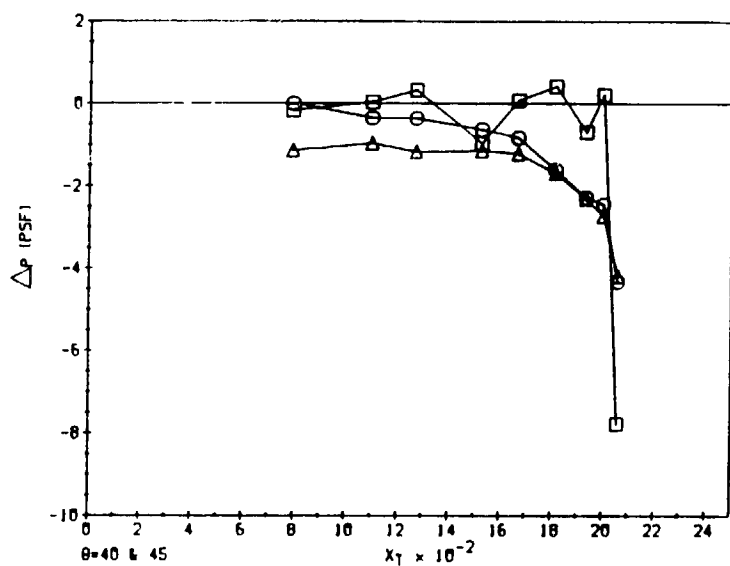
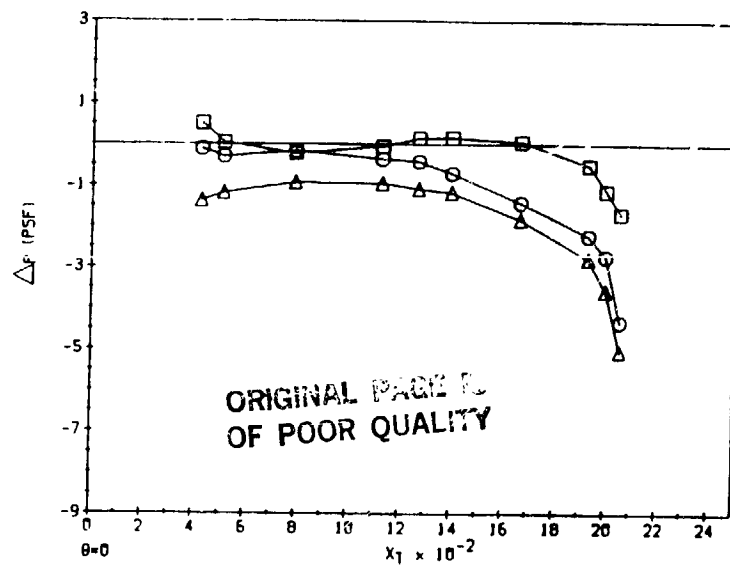
GROUP XX

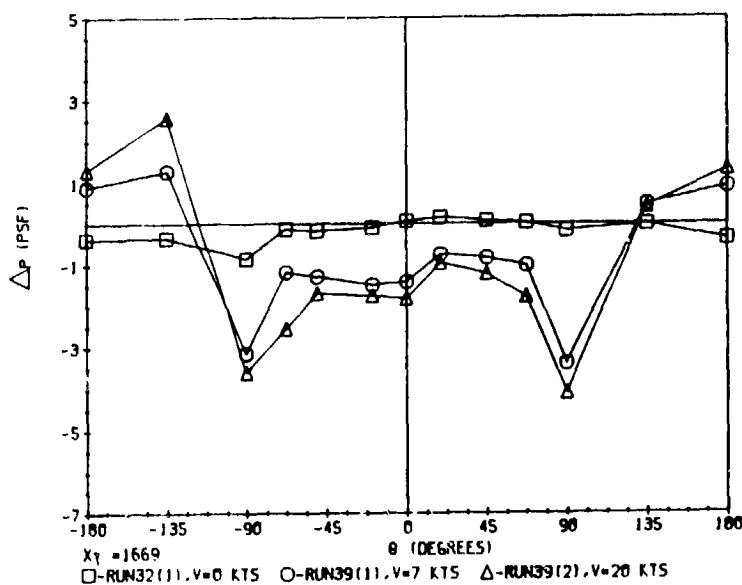
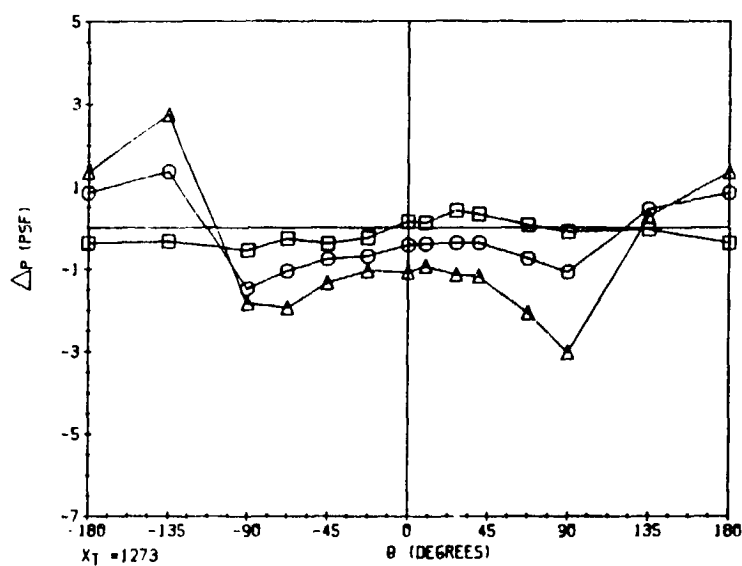
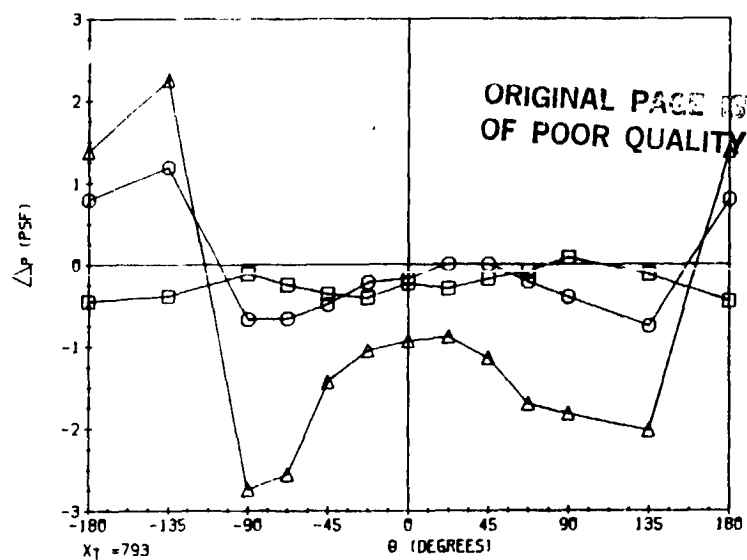
WIND VELOCITY EFFECTS AT 338°, HIGH FLOWRATE

RUNS 39.1 and 39.2

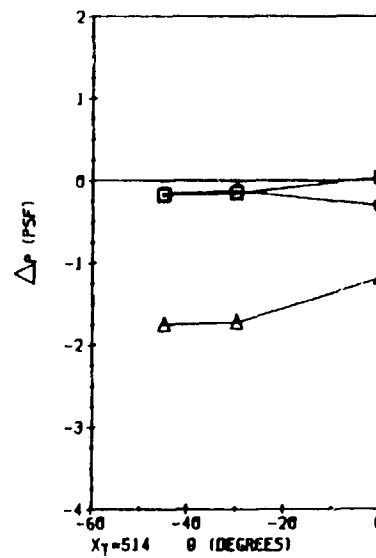
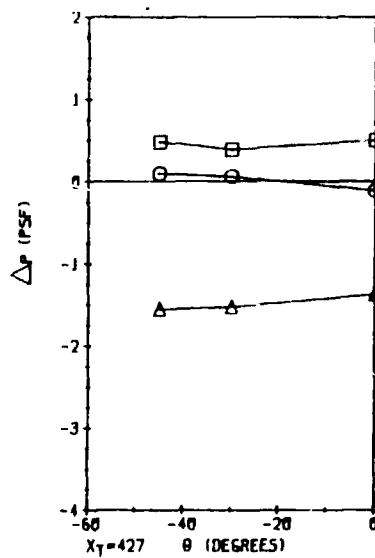
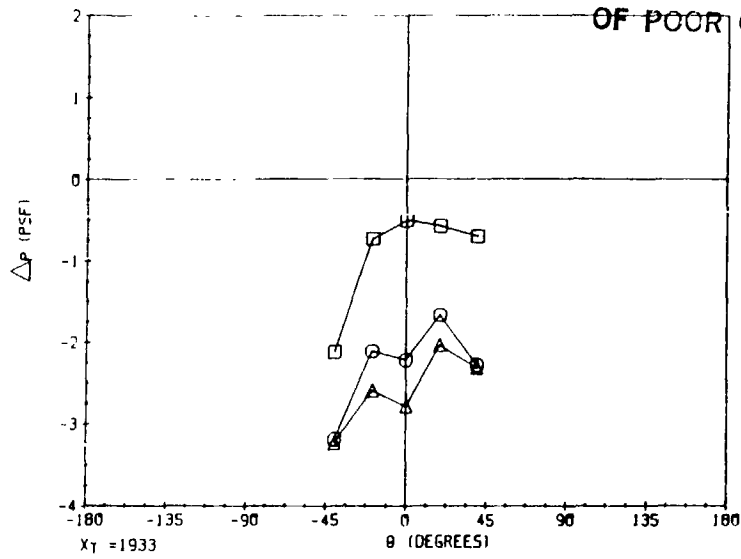
$\beta = 338^\circ$

High Flowrate





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□-RUN32(1), V=0 KTS ○-RUN39(1), V=7 KTS △-RUN39(2), V=20 KTS

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

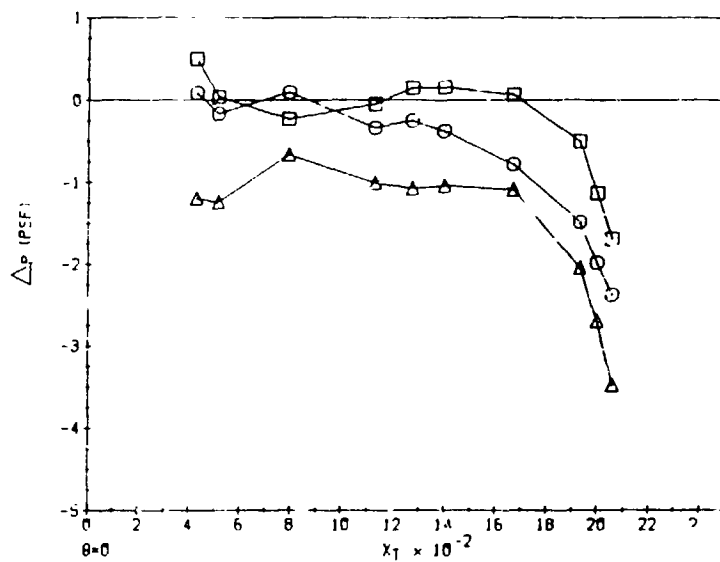
GROUP XXI

WIND VELOCITY EFFECTS AT 0°, HIGH FLOWRATE

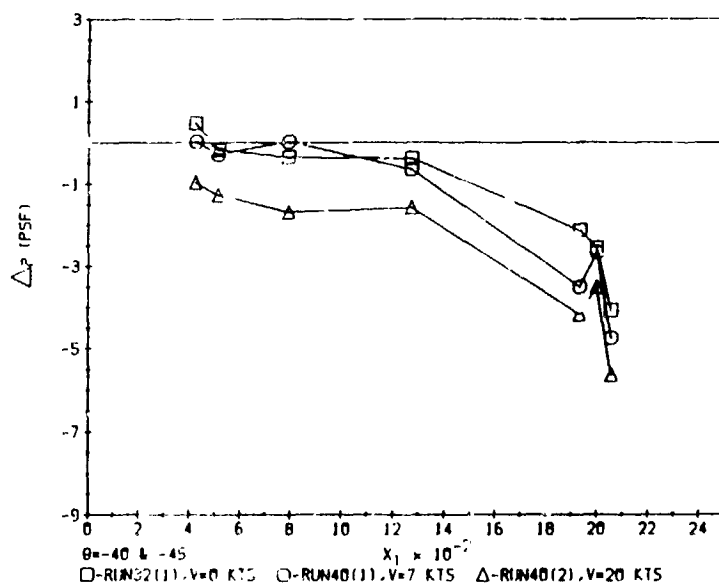
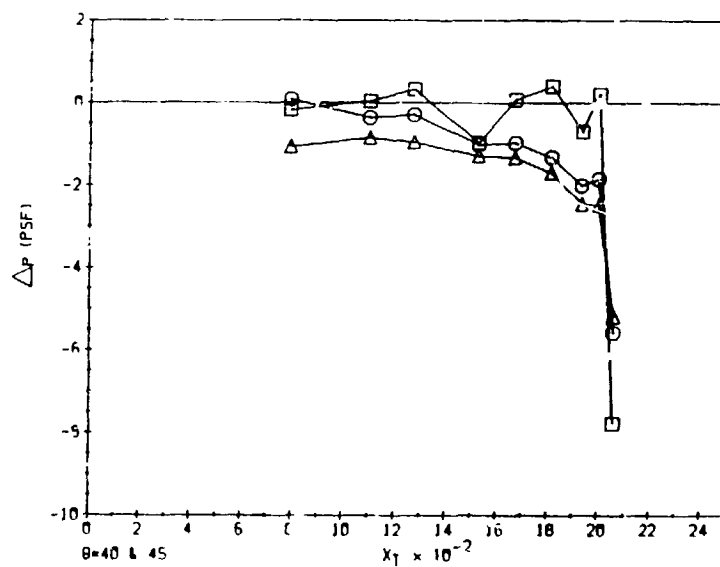
RUNS 40.1 and 40.2

$\beta = 0^\circ$

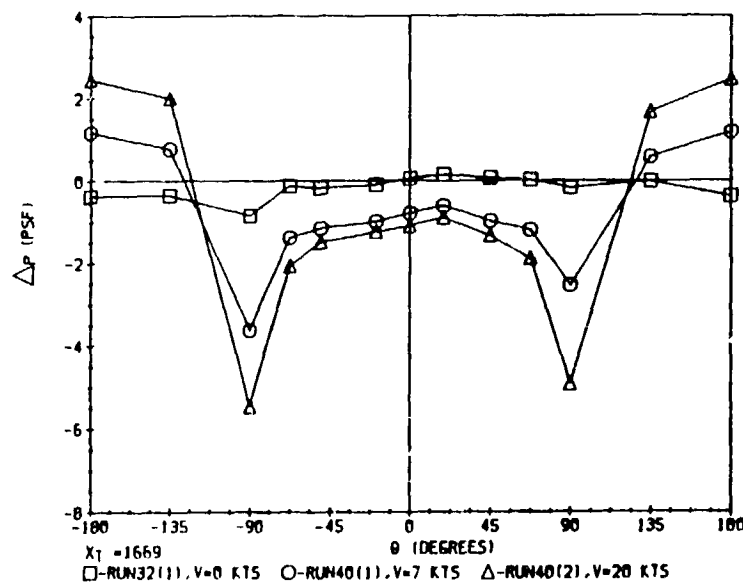
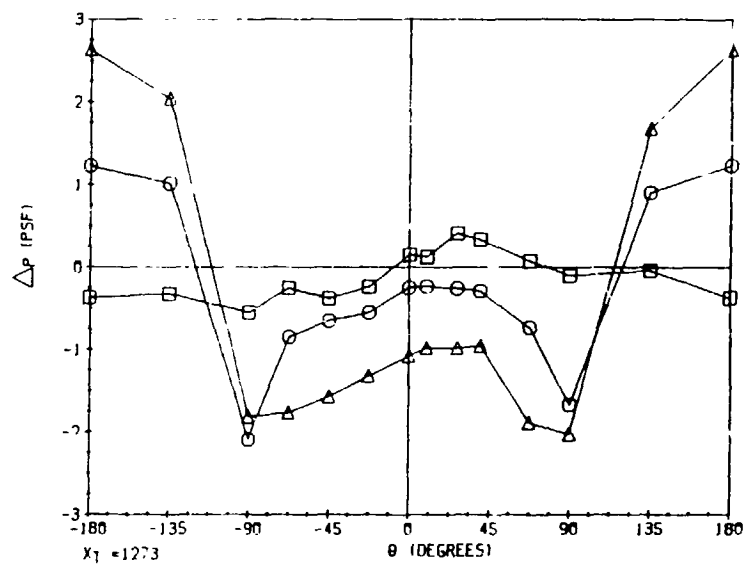
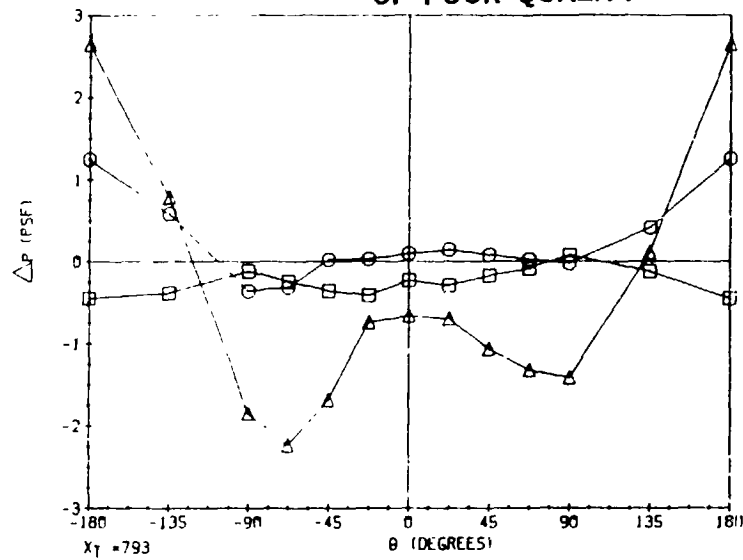
High Flowrate



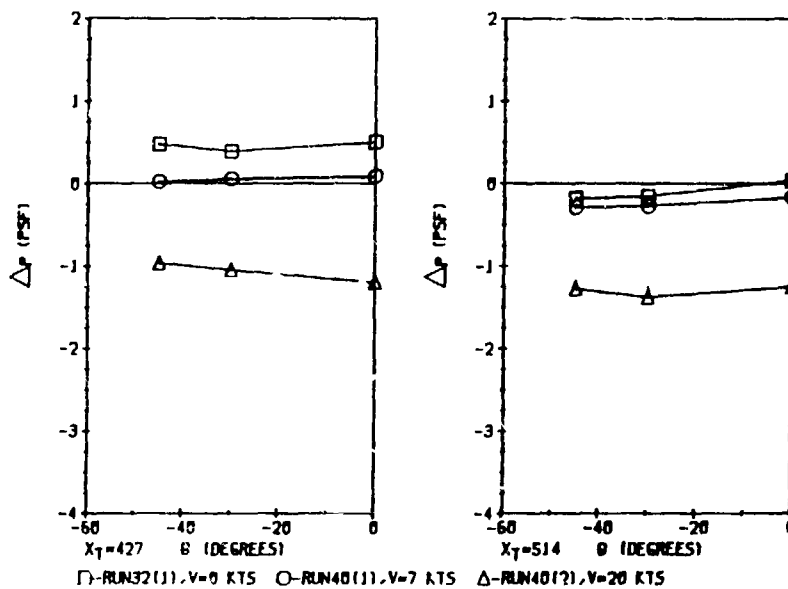
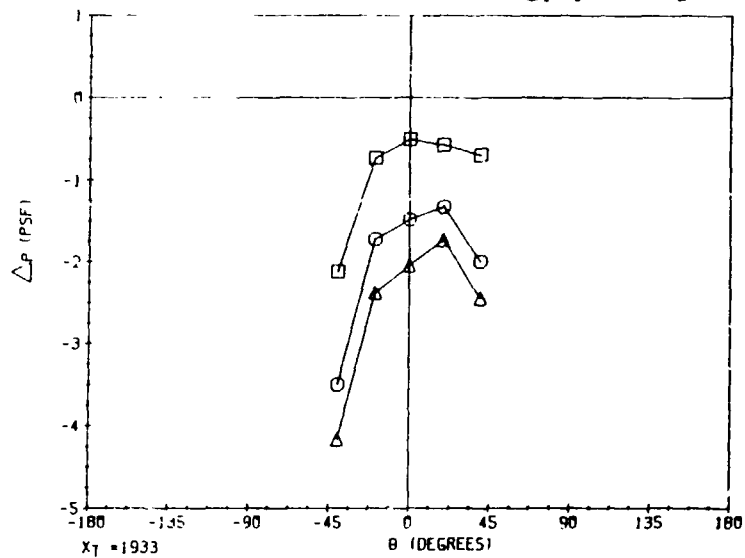
ORIGINAL LOCATION
OF PRESSURE TAP



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OF POOR QUALITY



ORIGINAL PAGE 10
OF POOR QUALITY



MARSHALL SPACE FLIGHT CENTER CONFIGURATION

GROUP XXII

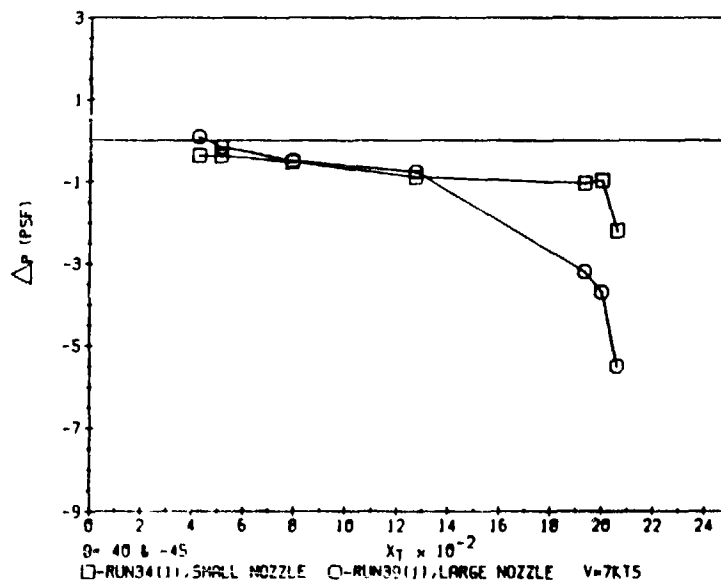
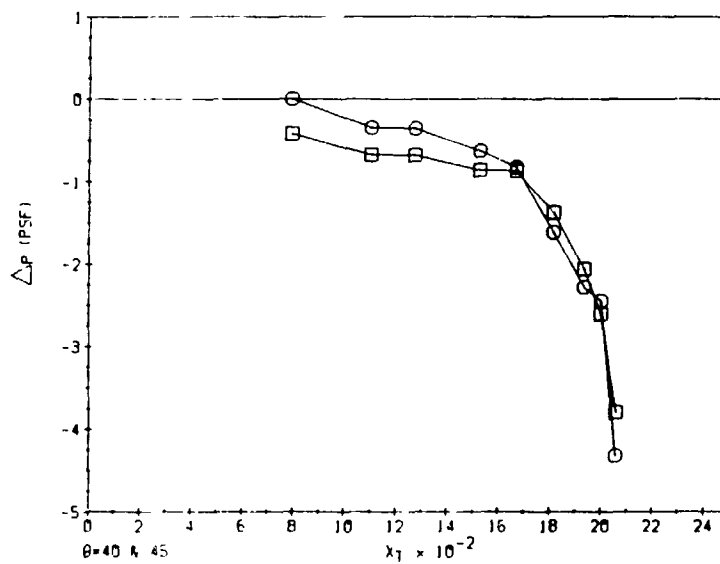
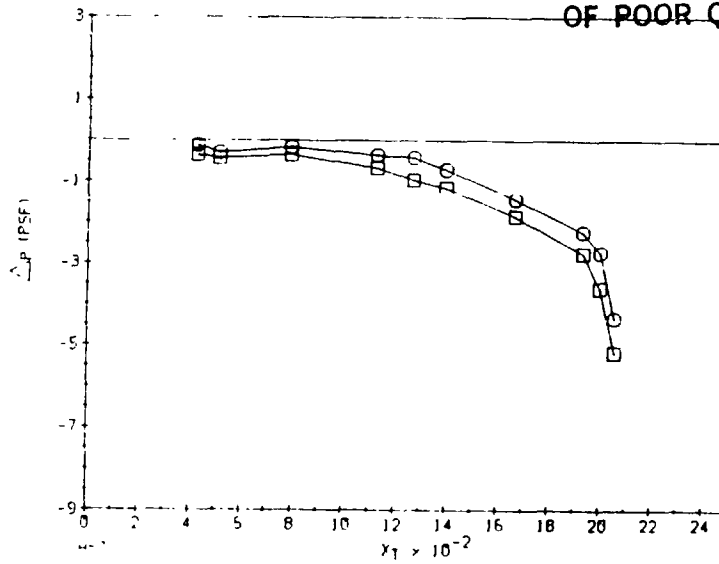
FLOWRATE EFFECTS AT 7 KT

RUNS 34.1 and 39.1

$V = 7$ KNOTS

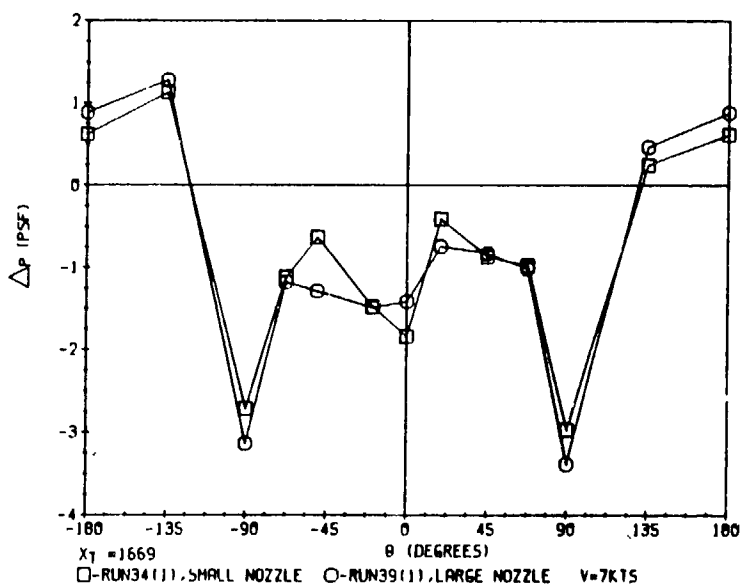
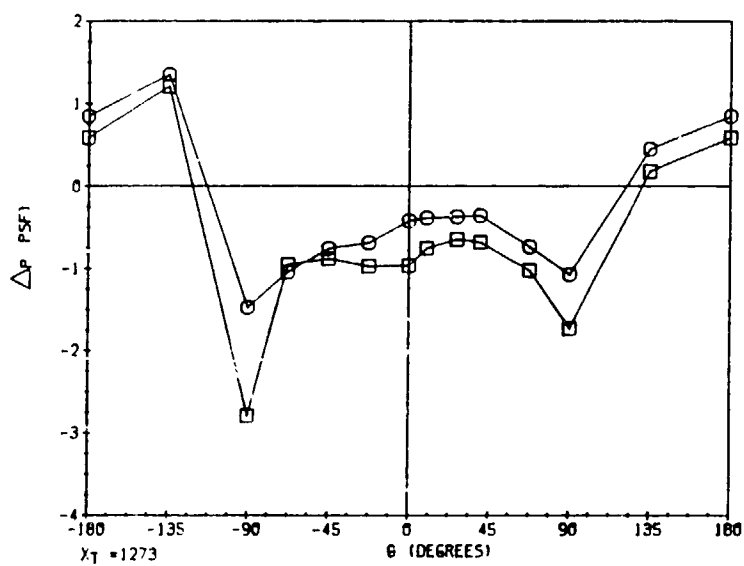
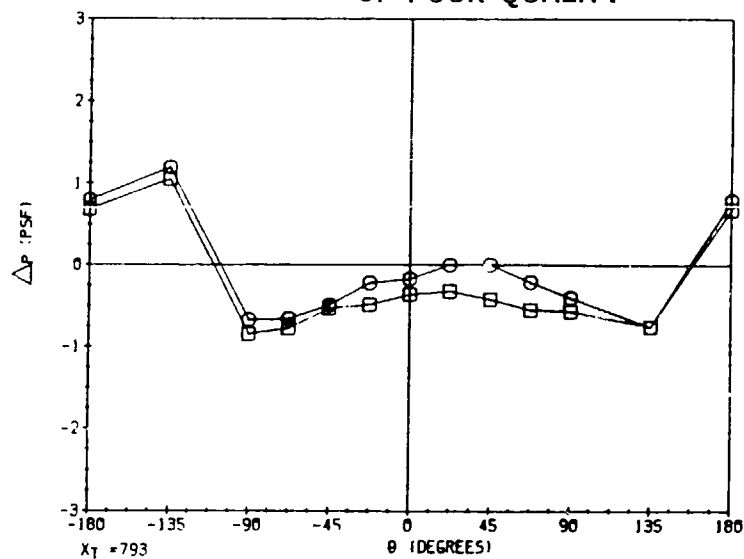
$\beta = 338^\circ$

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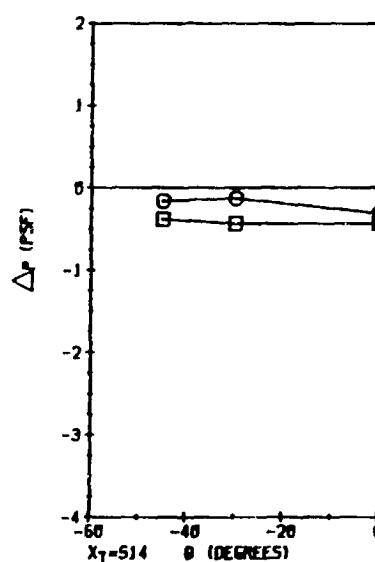
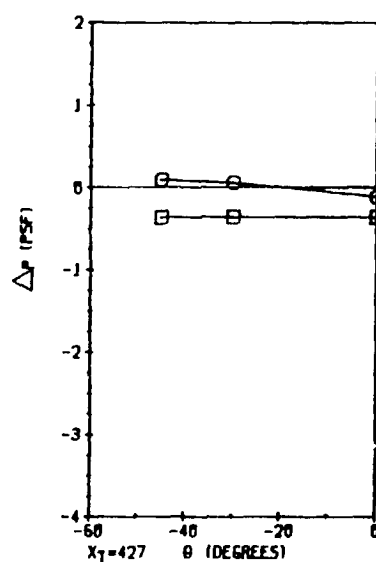
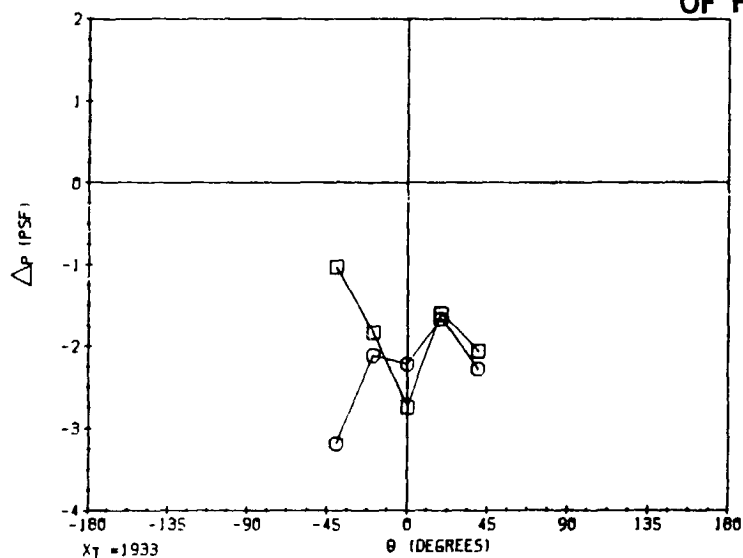


$\theta = 40^\circ \& 45^\circ$ $X_1 \times 10^{-2}$
 □ - RUN 34(1), SMALL NOZZLE ○ - RUN 39(1), LARGE NOZZLE $V = 7 \times 15$

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OF POOR QUALITY



□-RUN34(1), SMALL NOZZLE ○-RUN39(1), LARGE NOZZLE $V=7RTS$

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

GROUP XXIII

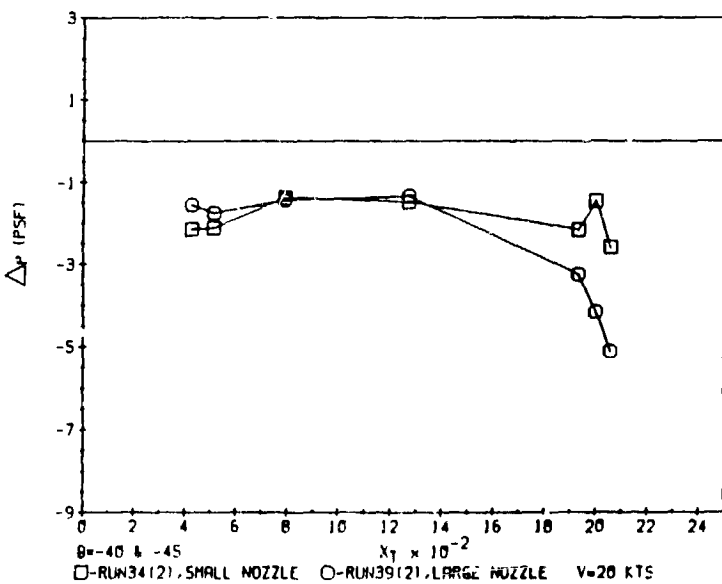
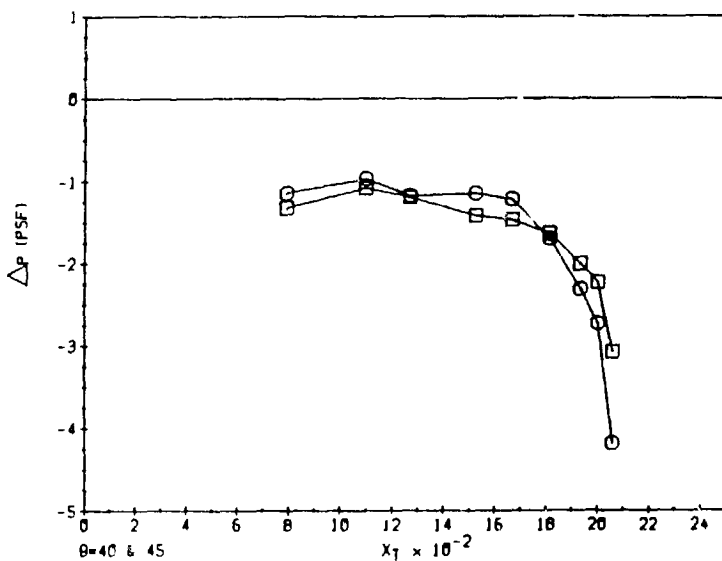
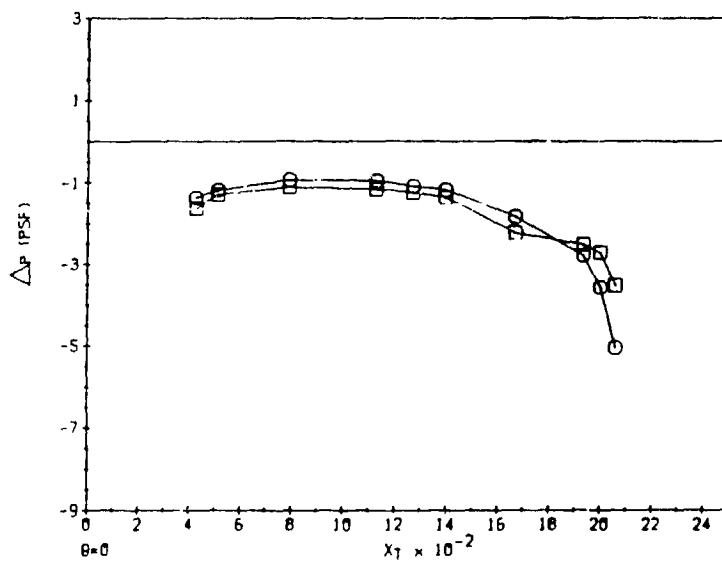
FLOWRATE EFFECTS AT 20 KT

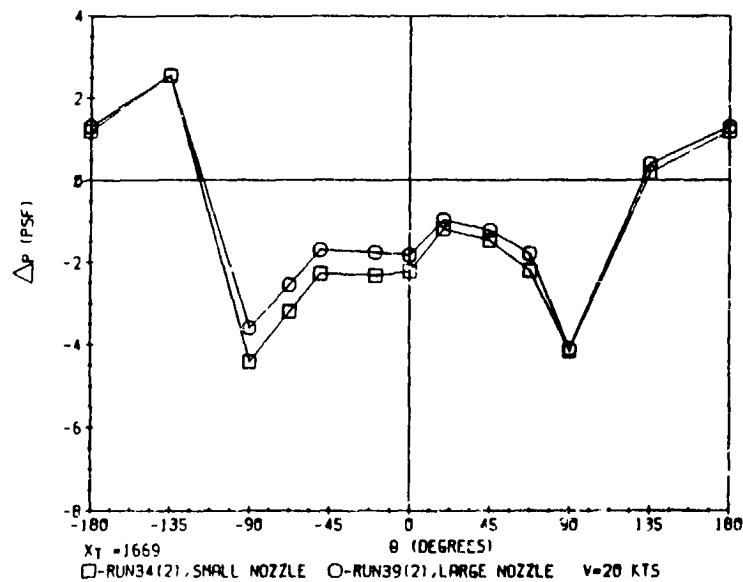
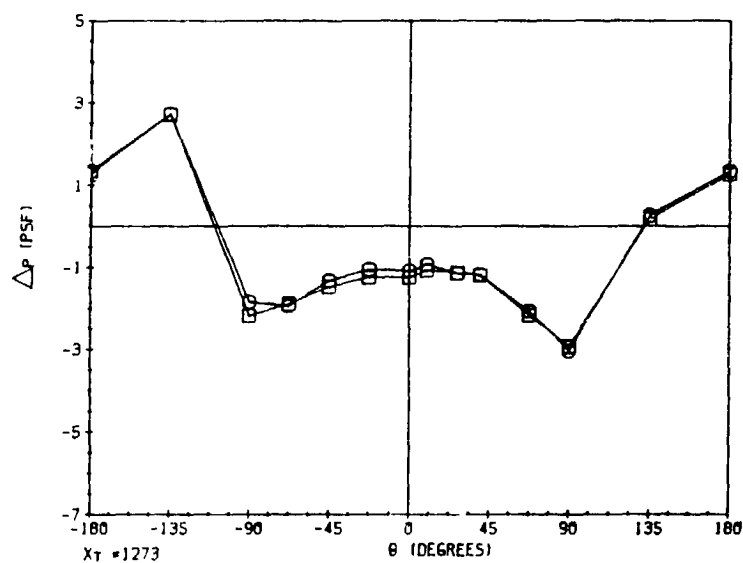
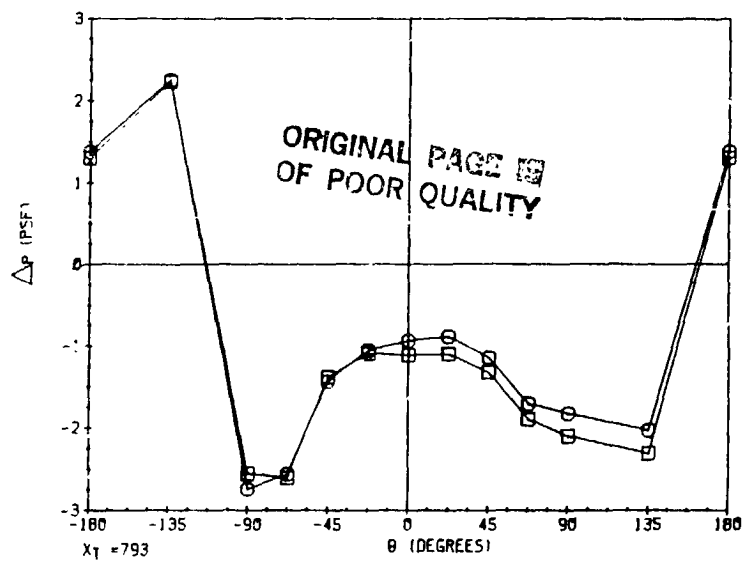
RUNS 34.2 and 39.2

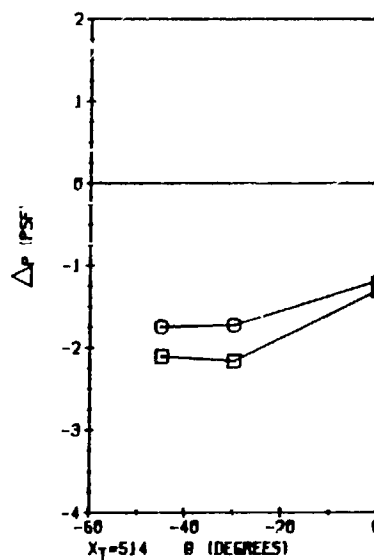
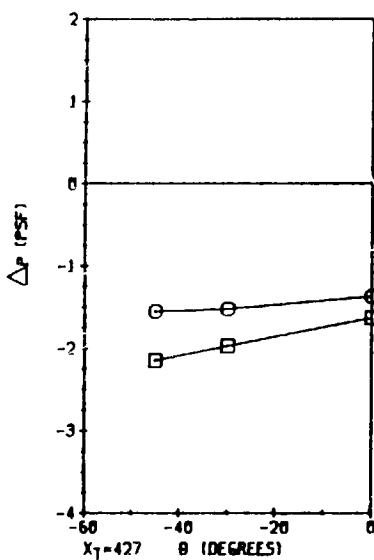
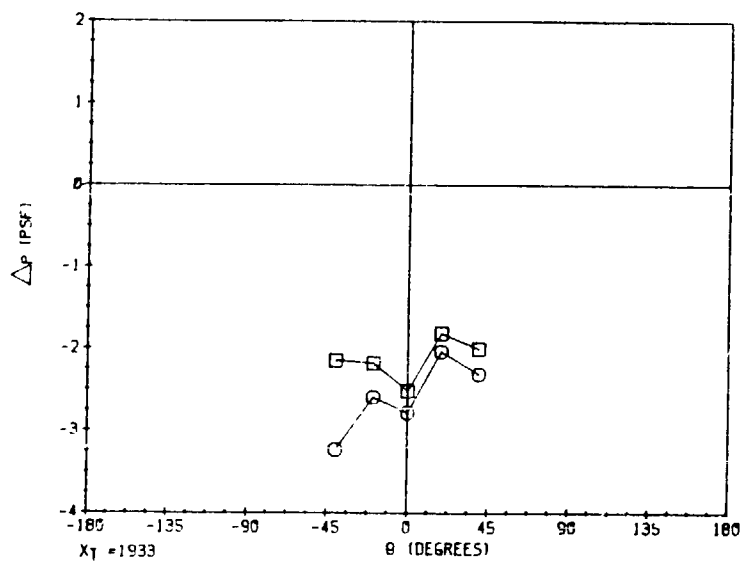
$V = 20$ KNOTS

$\beta = 338^\circ$

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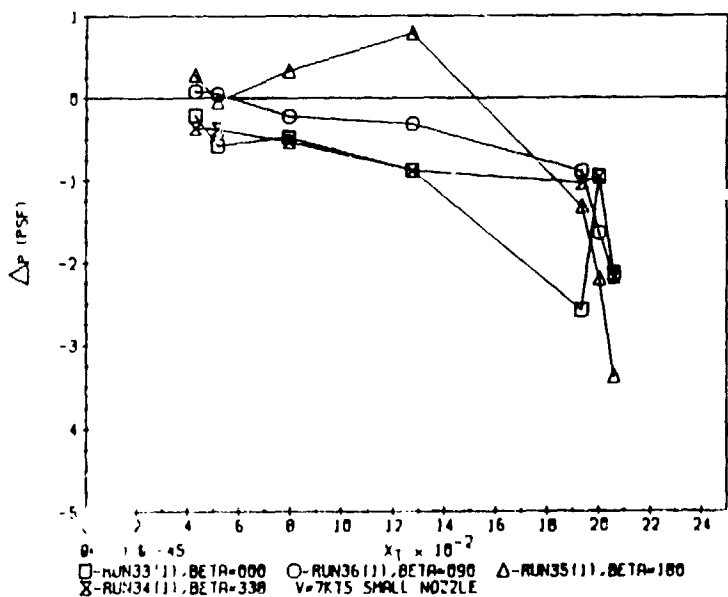
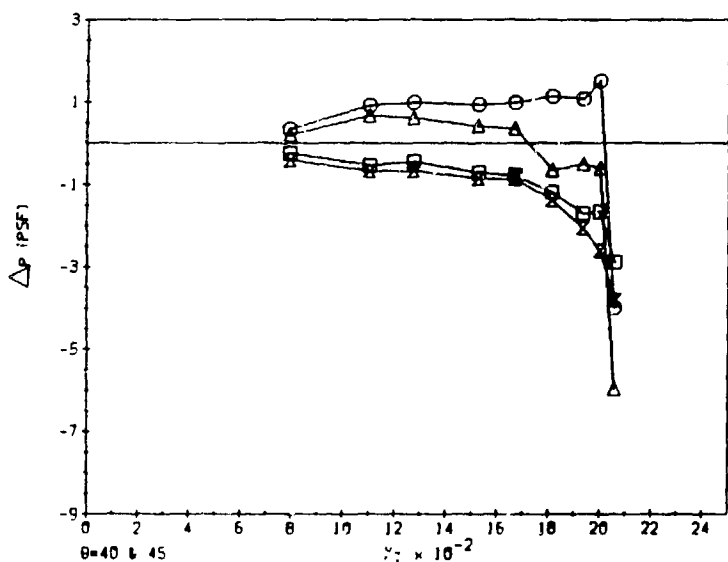
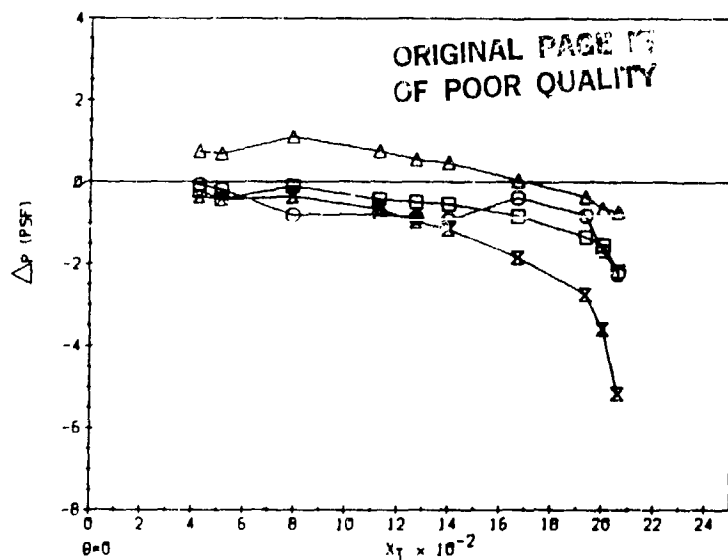
□ - RUN 34121, SMALL NOZZLE ○ - RUN 39121, LARGE NOZZLE V = 20 KTS

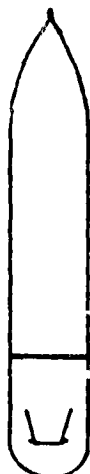
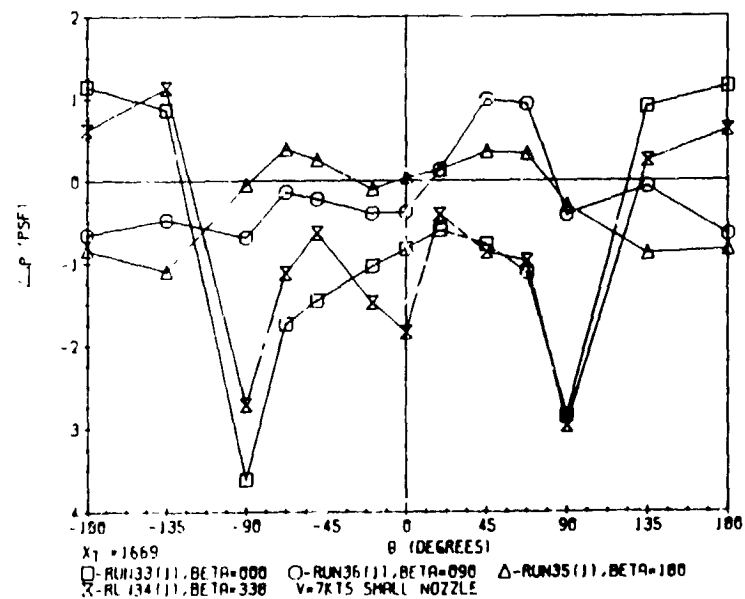
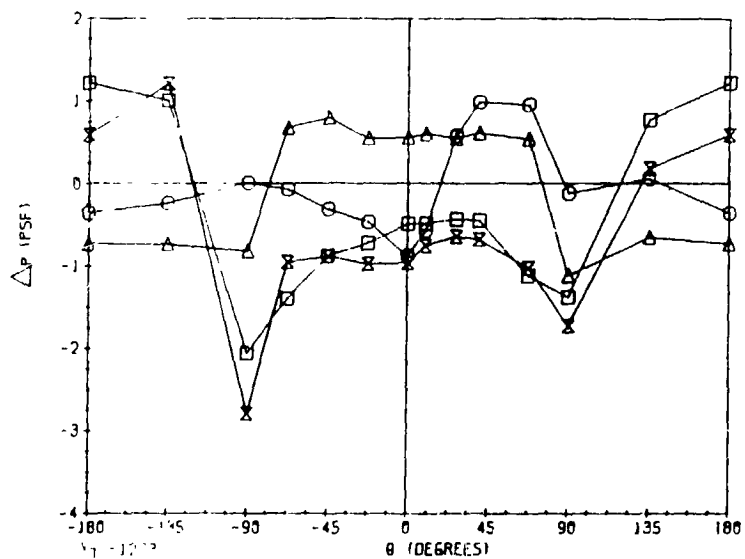
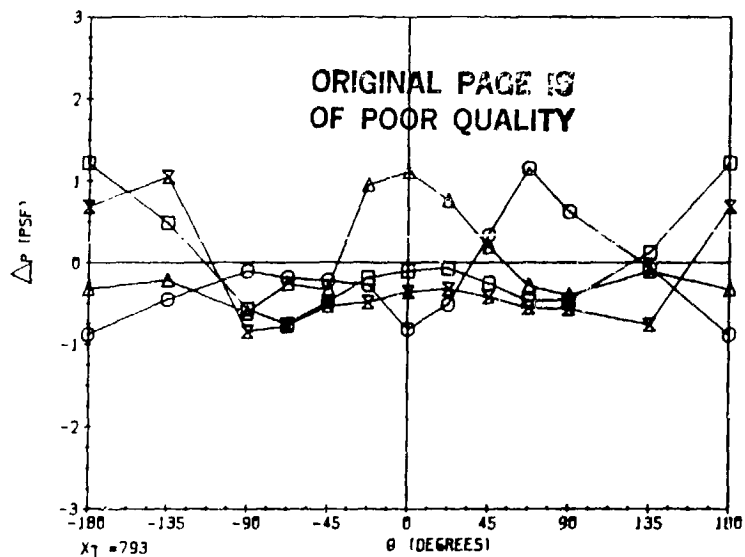
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OF POOR QUALITY

MARSHALL SPACE FLIGHT CENTER CONFIGURATION
GROUP XXIV
WIND DIRECTION EFFECTS AT 7 KT, LOW FLOWRATE
RUNS 33.1, 36.1, 35.1 and 34.1

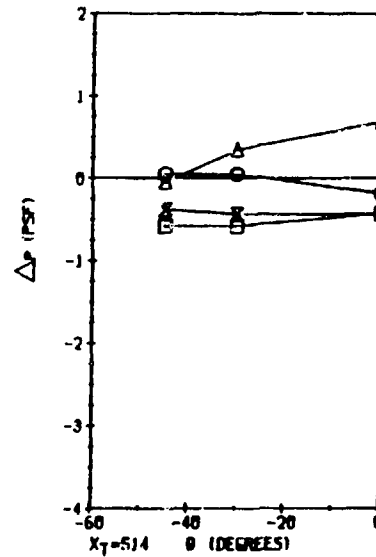
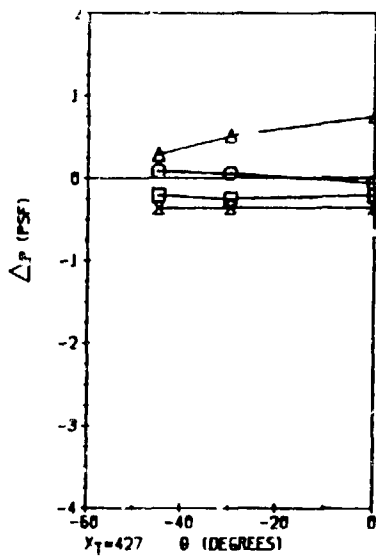
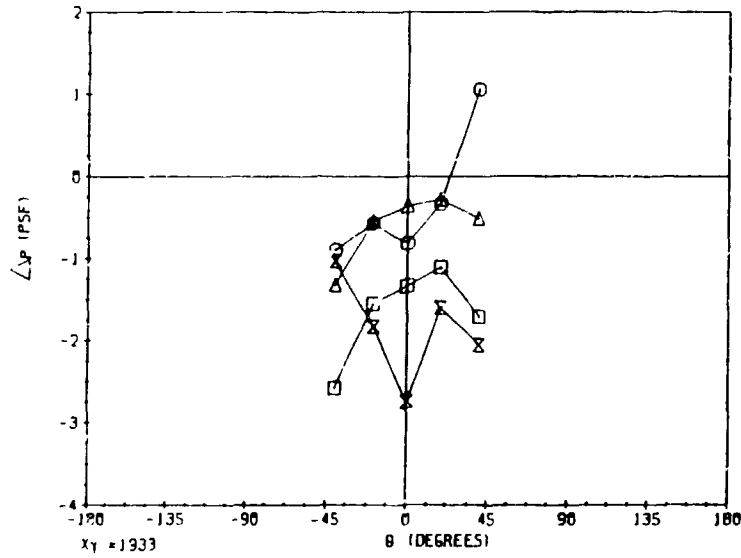
V = 7 KNOTS

Low Flowrate





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\square - RUN 33 (1), BETA = 0.50
 \times - RUN 34 (1), BETA = 3.50
 \circ - RUN 36 (1), BETA = 0.90
 Δ - RUN 35 (1), BETA = 1.80
 V = 7 KTS SMALL NOZZLE

C-2

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

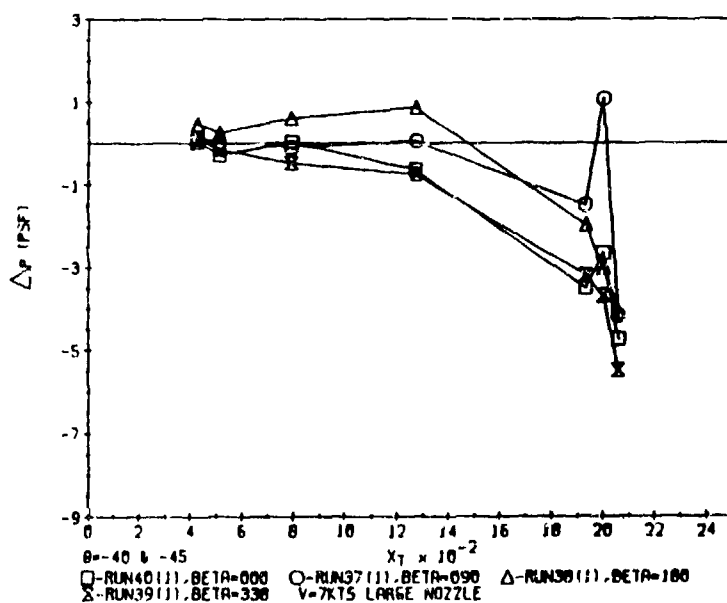
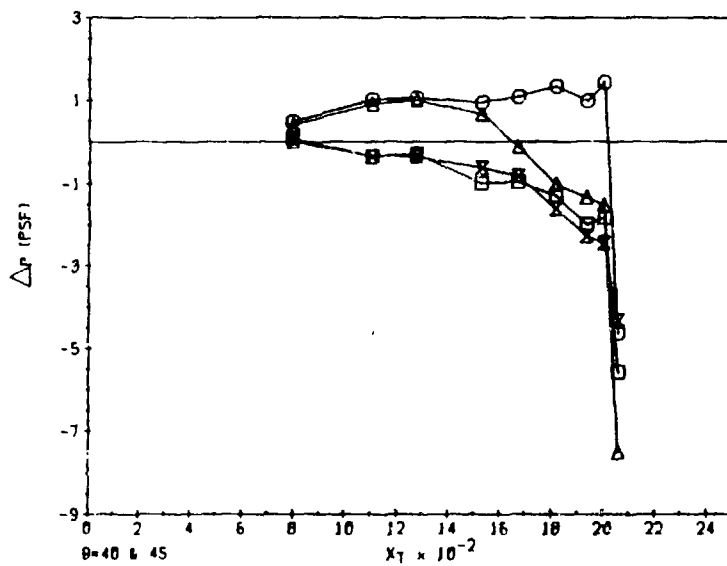
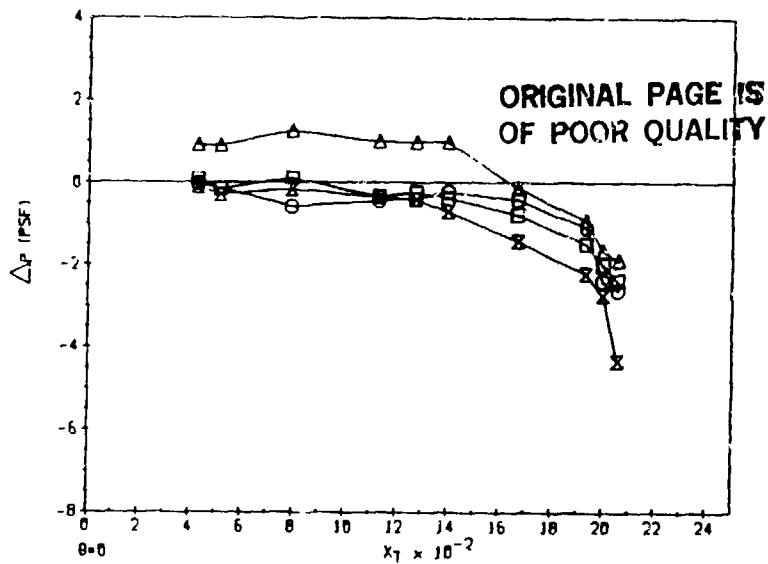
GROUP XXV

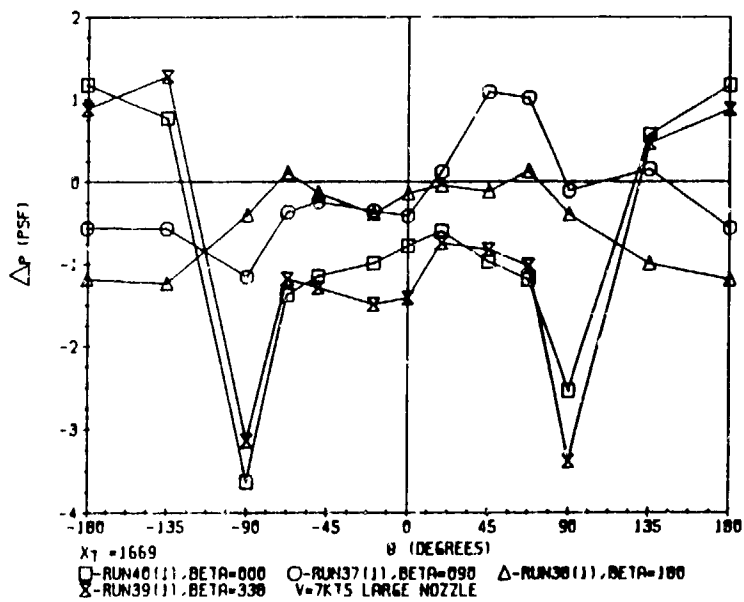
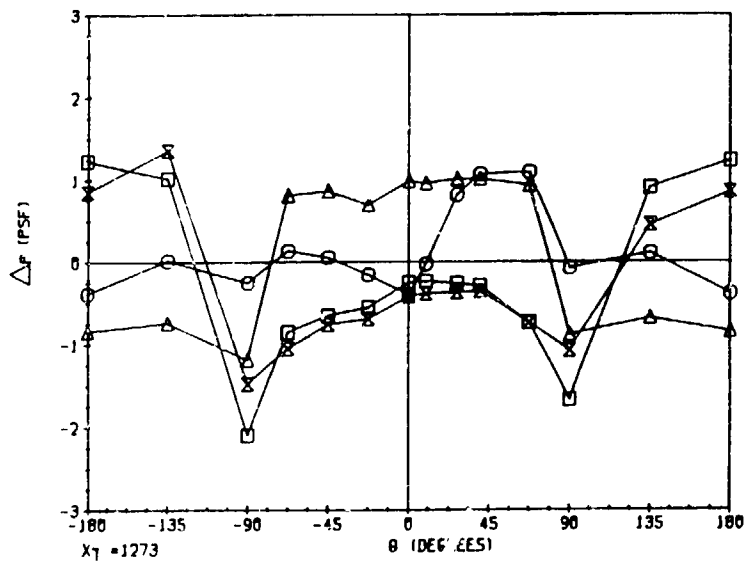
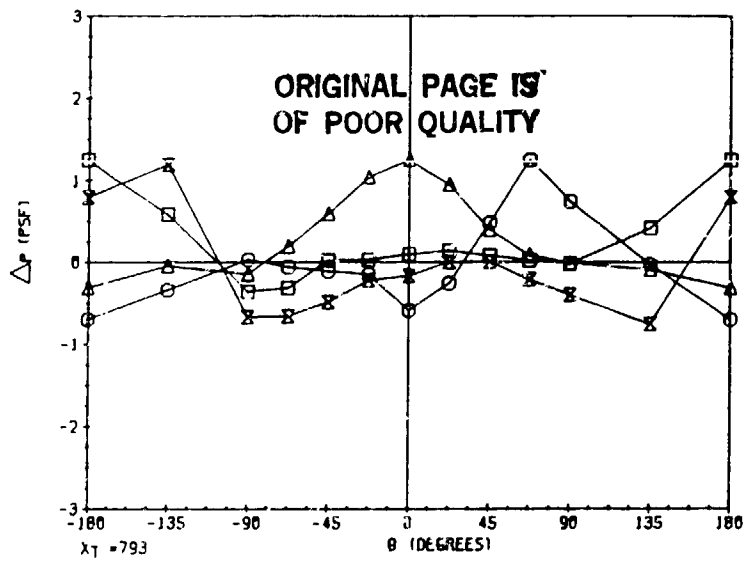
WIND DIRECTION EFFECTS AT 7 KT, HIGH FLOWRATE

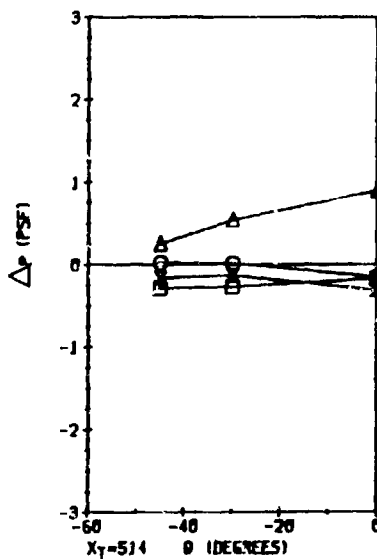
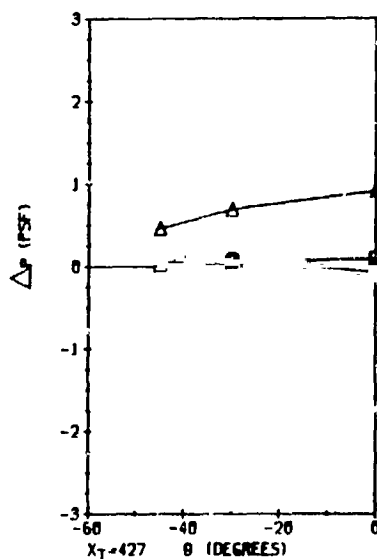
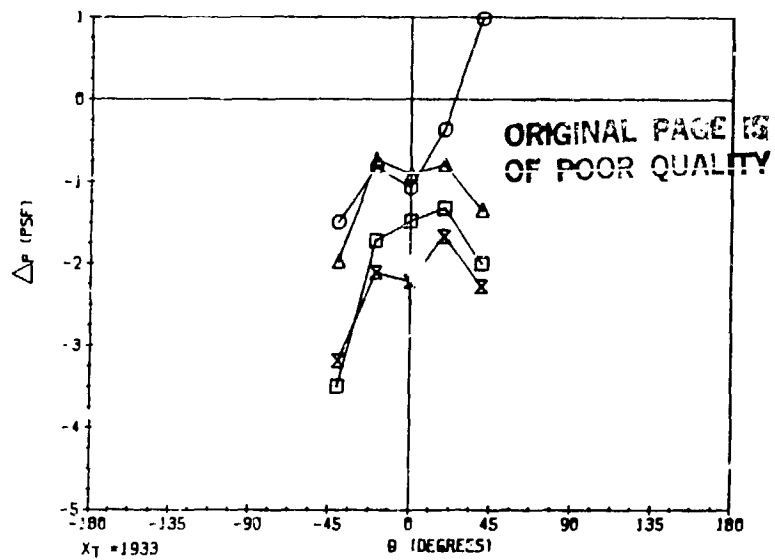
RUNS 40.1, 37.1, 38.1 and 39.1

V = 7 KNOTS

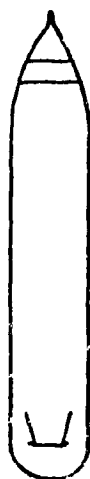
High Flowrate







\square - RUN 4011, BETA = 0.00
 \circ - RUN 3711, BETA = 0.09
 \times - RUN 3911, BETA = 3.30
 Δ - RUN 3811, BETA = 1.00
 V - 7KTS LARGE NOZZLE



MARSHALL SPACE FLIGHT CENTER CONFIGURATION

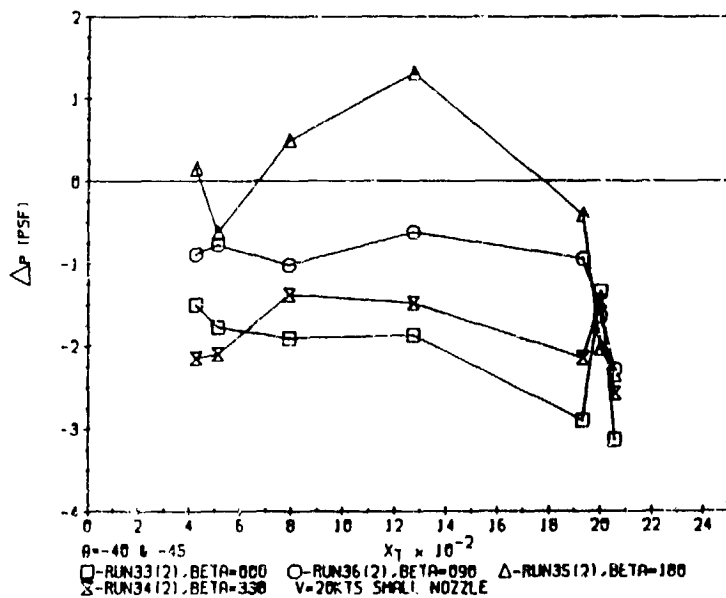
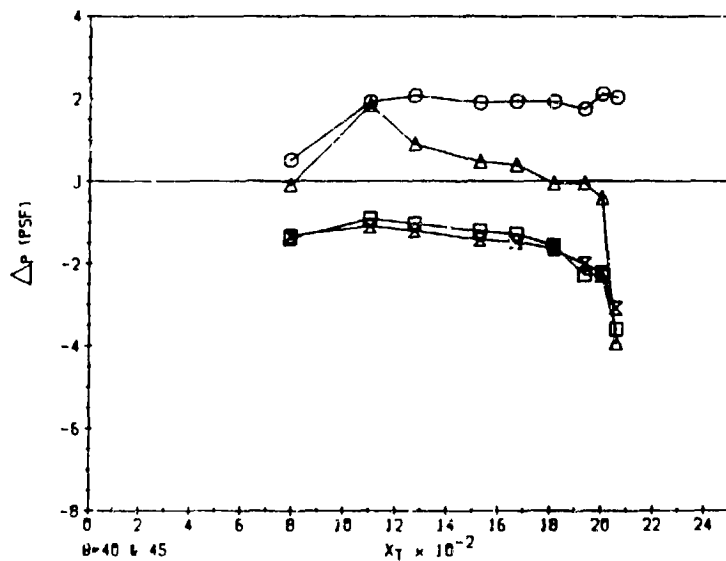
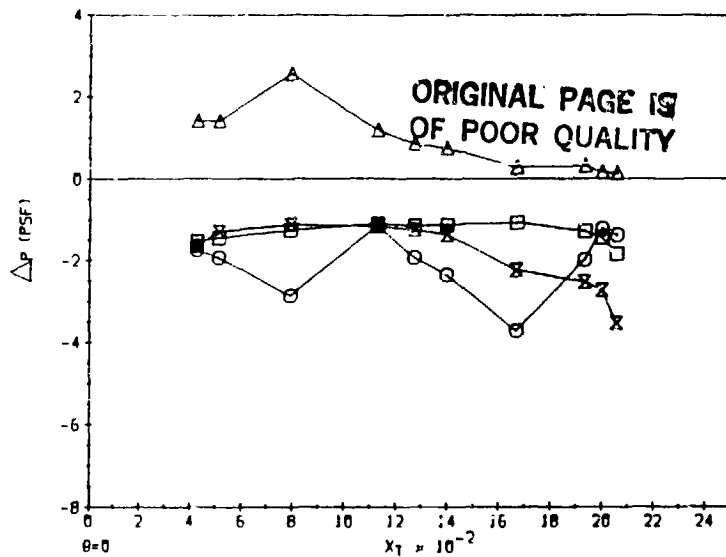
GROUP XXVI

WIND DIRECTION EFFECTS AT 20 KT, LOW FLOWRATE

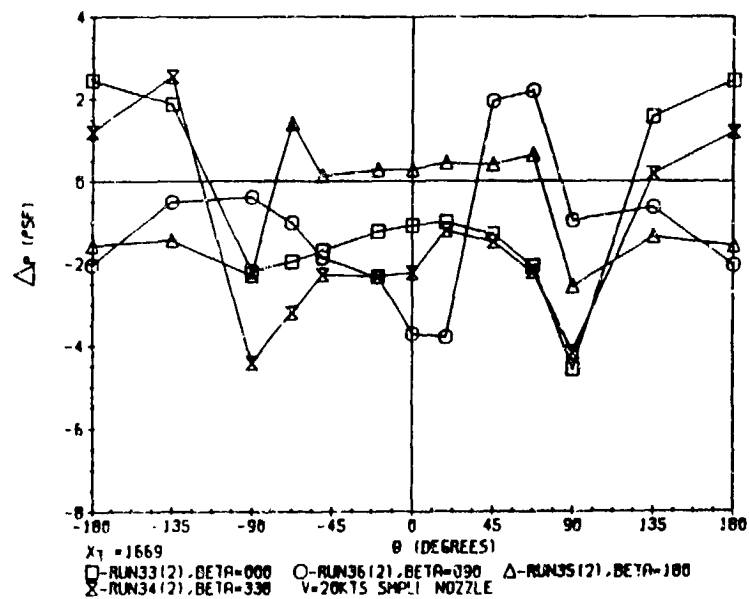
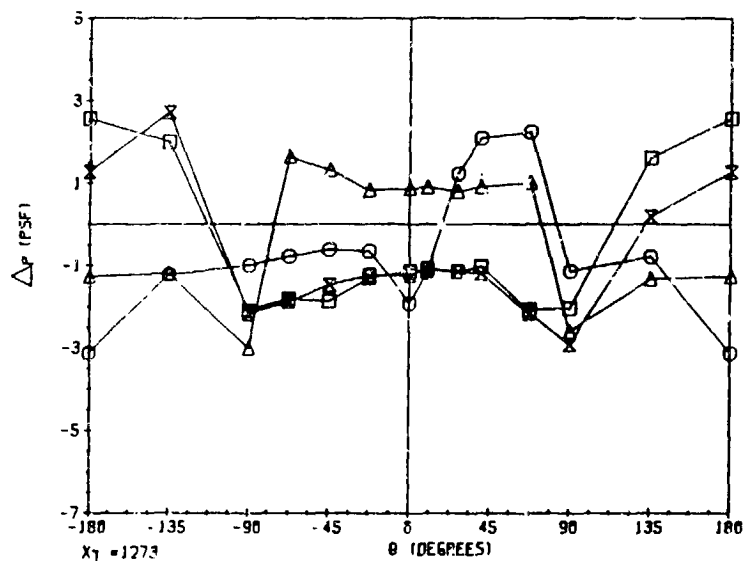
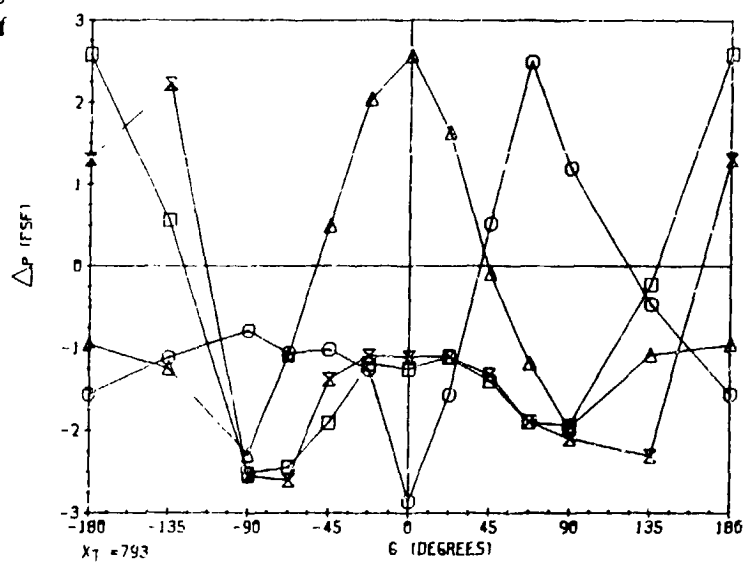
RUNS 33.2, 36.2, 35.2 and 34.2

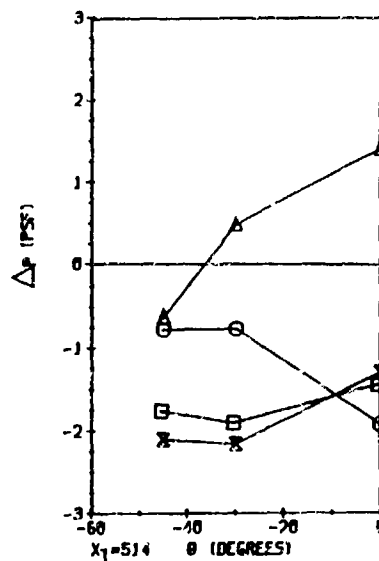
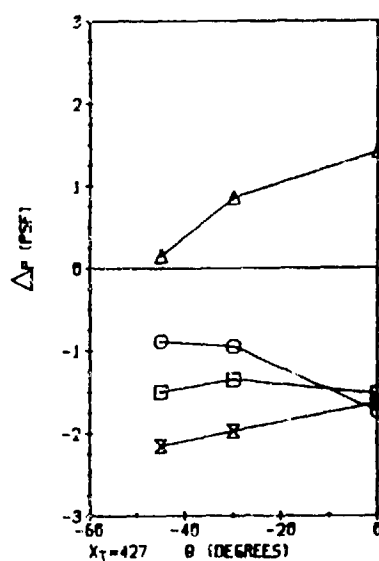
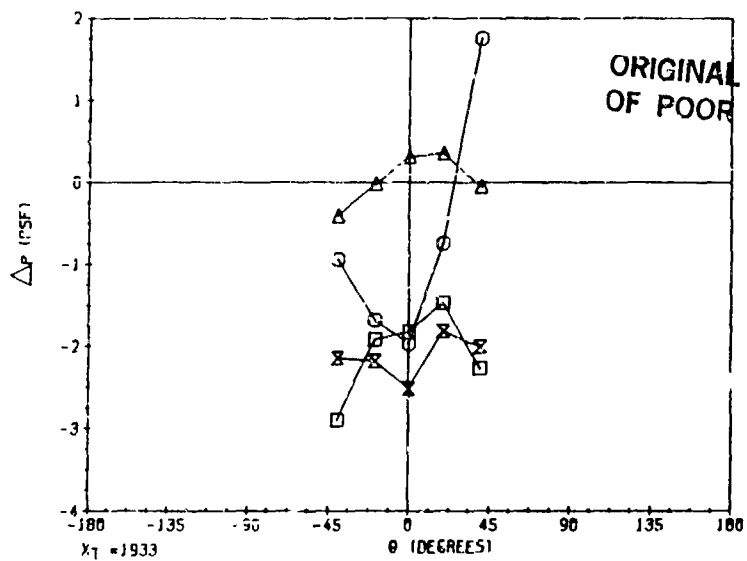
V = 20 KNOTS

Low Flowrate



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\square - RUN33(2), BETA=000 \circ - RUN36(2), BETA=090 Δ - RUN35(2), BETA=100
 \times - RUN34(2), BETA=330 V=20KTS SMALL NOZZLE

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

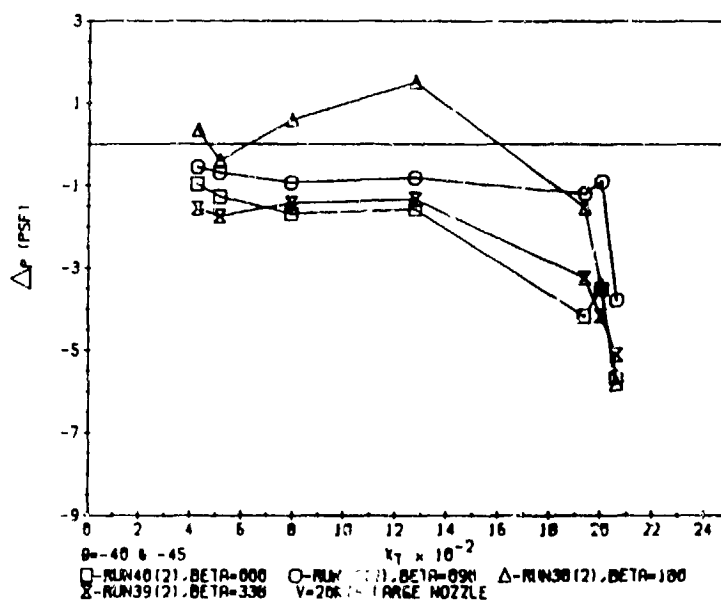
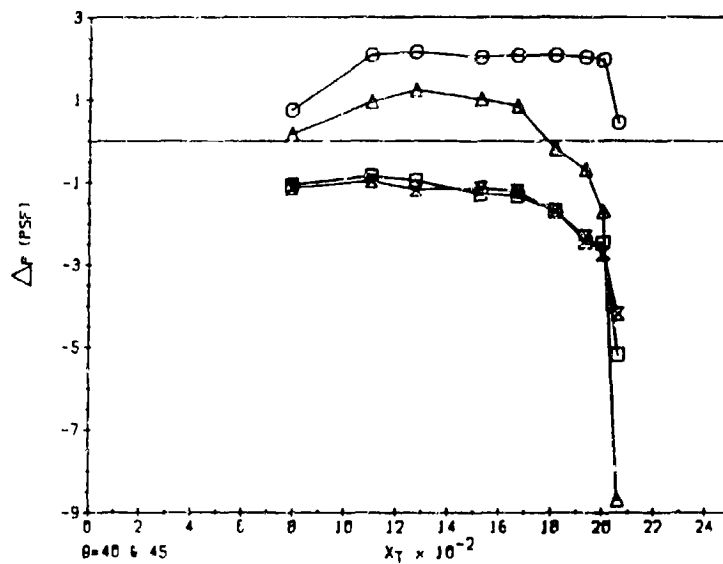
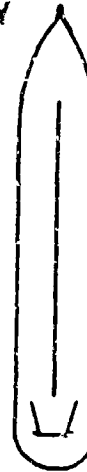
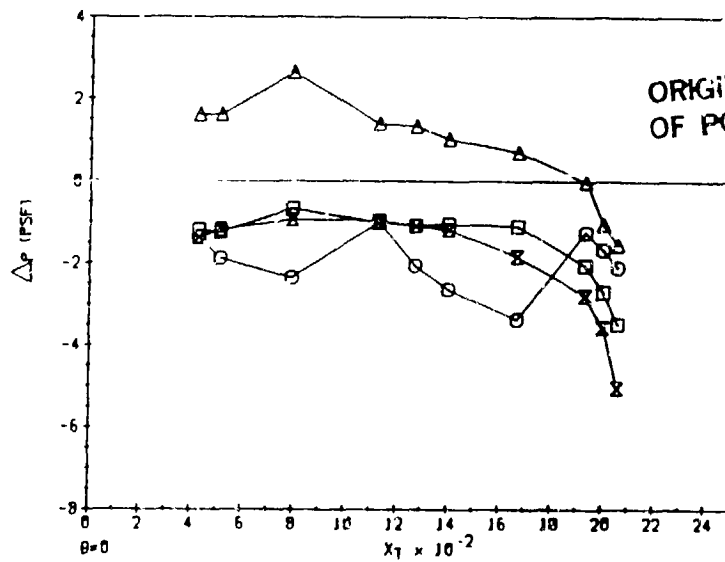
GROUP XXVII

WIND DIRECTION EFFECTS AT 20 KT, HIGH FLOWRATE

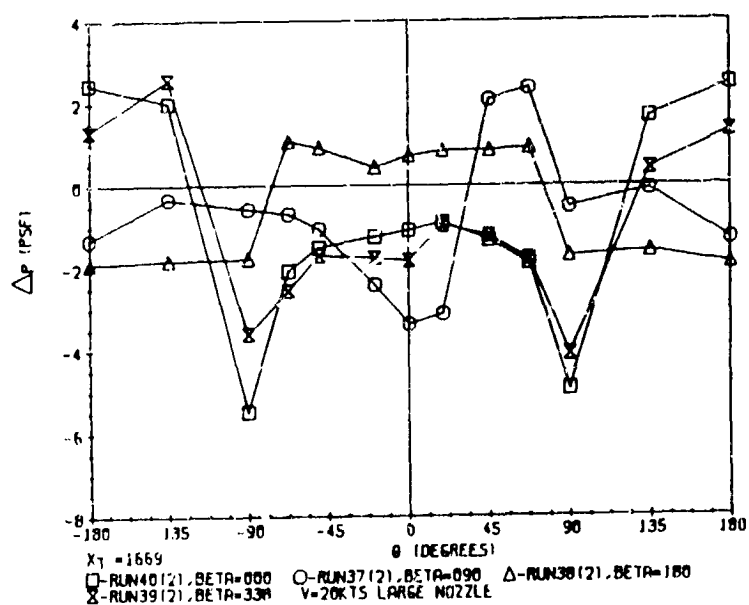
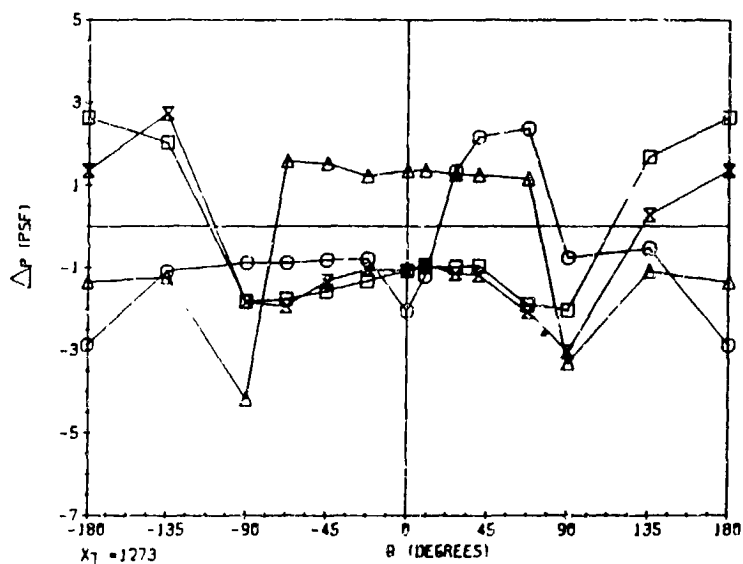
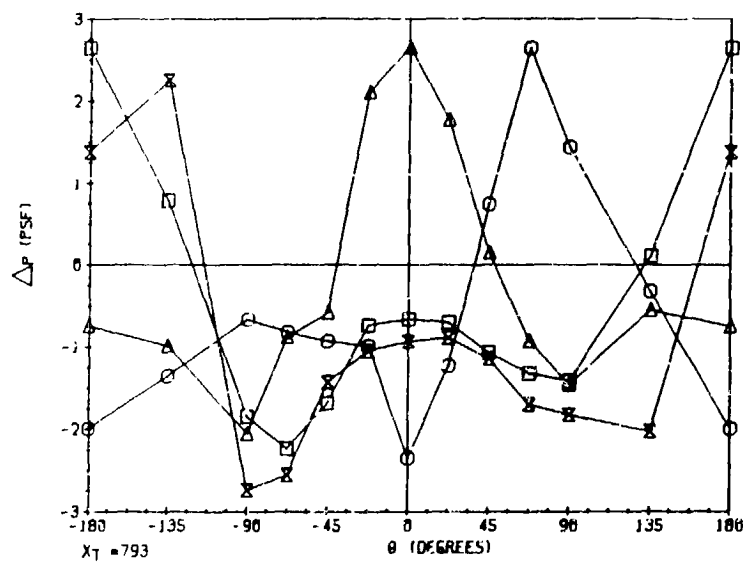
RUNS 40.2, 37.2, 38.2 and 39.2

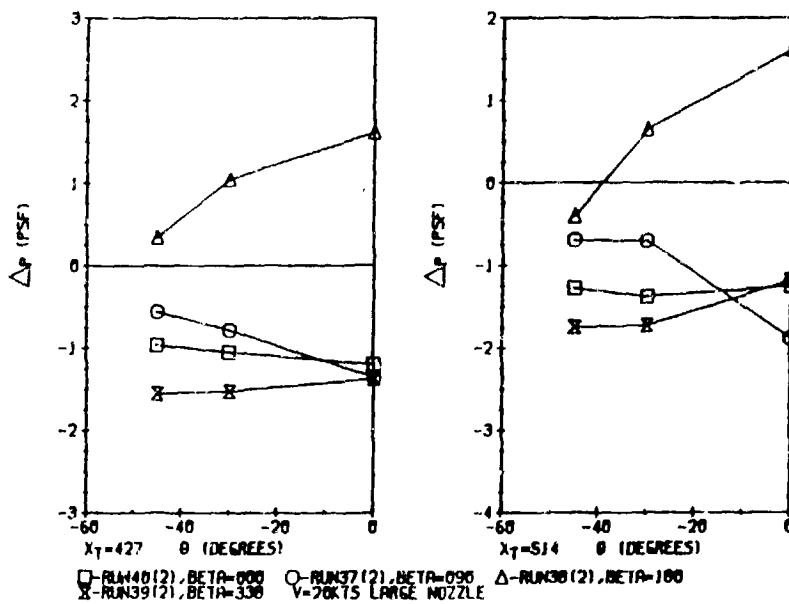
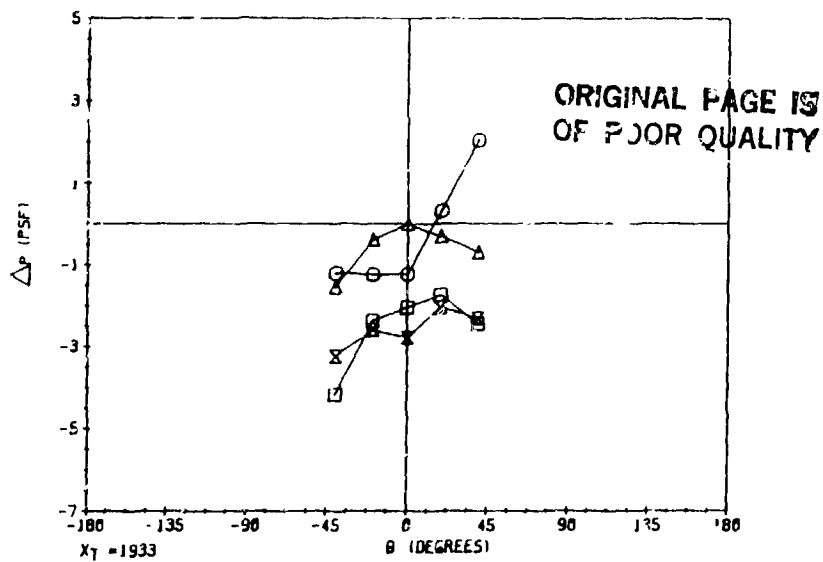
V = 20 KNOTS

High Flowrate



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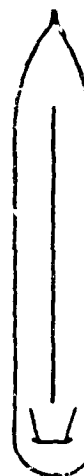
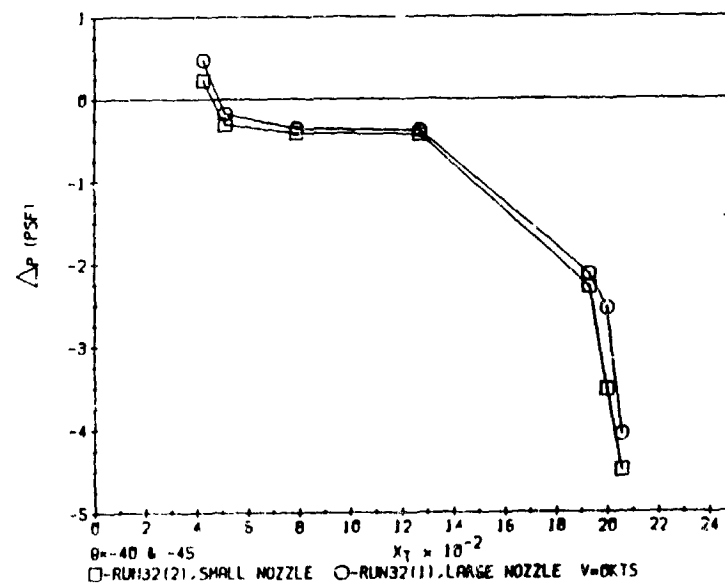
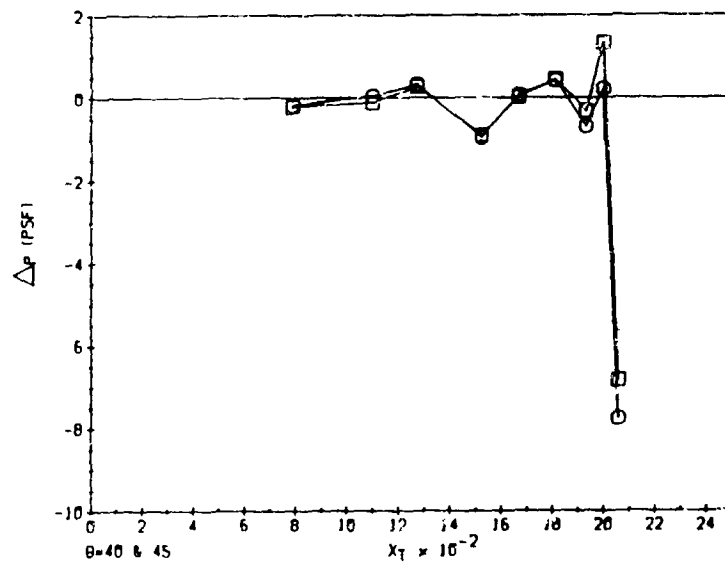
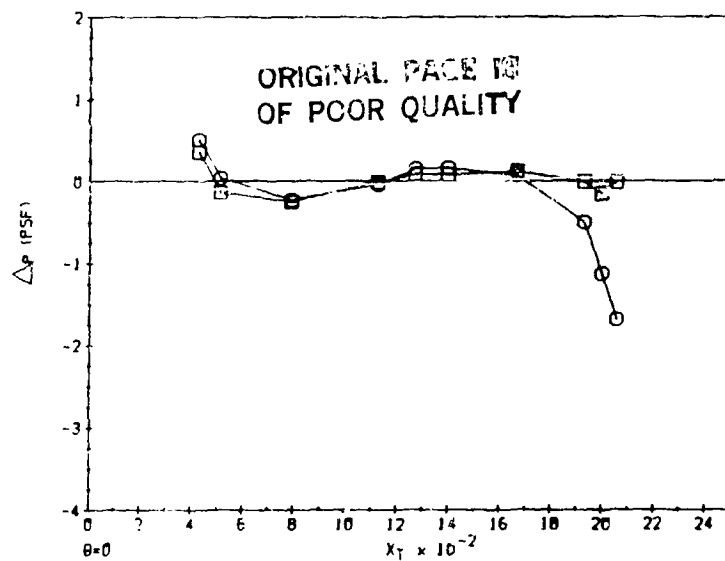
MARSHALL SPACE FLIGHT CENTER CONFIGURATION

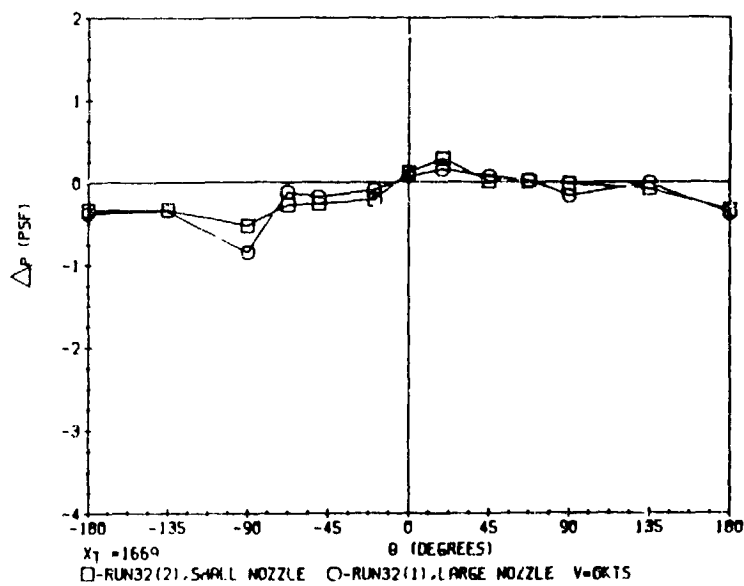
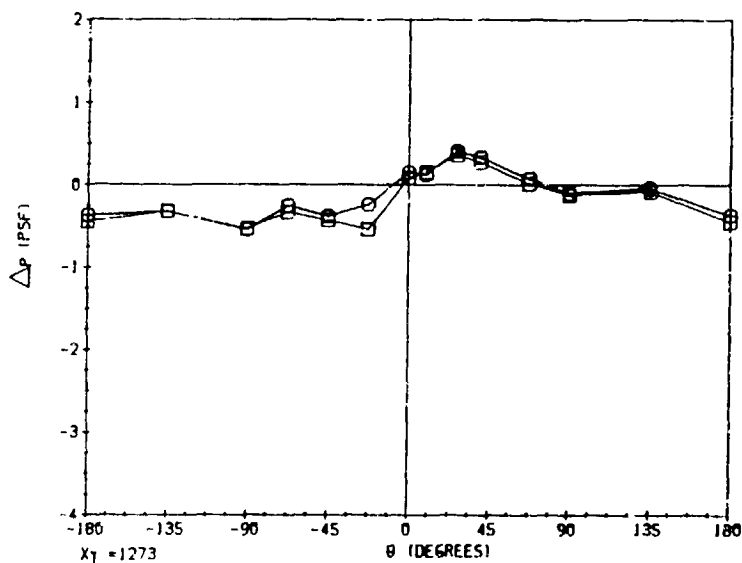
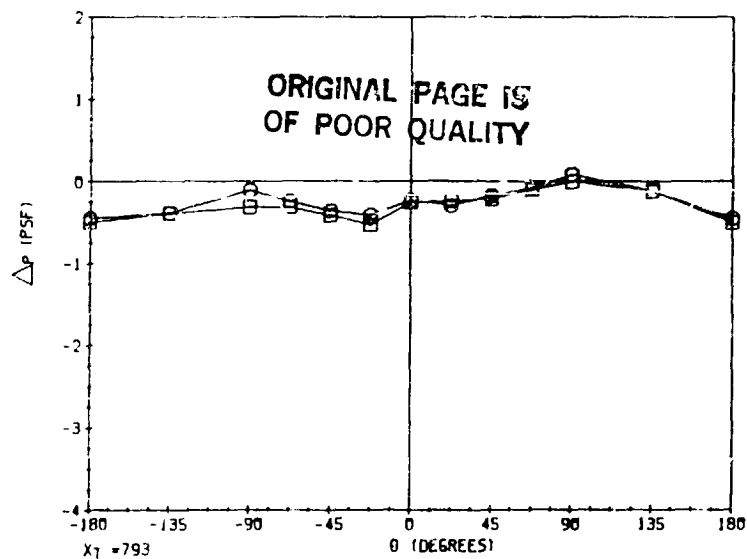
GROUP XXVIII

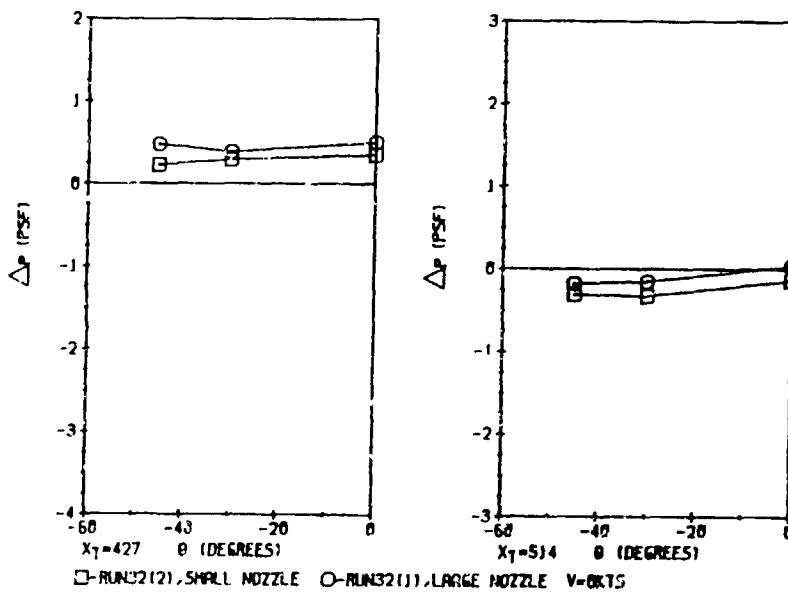
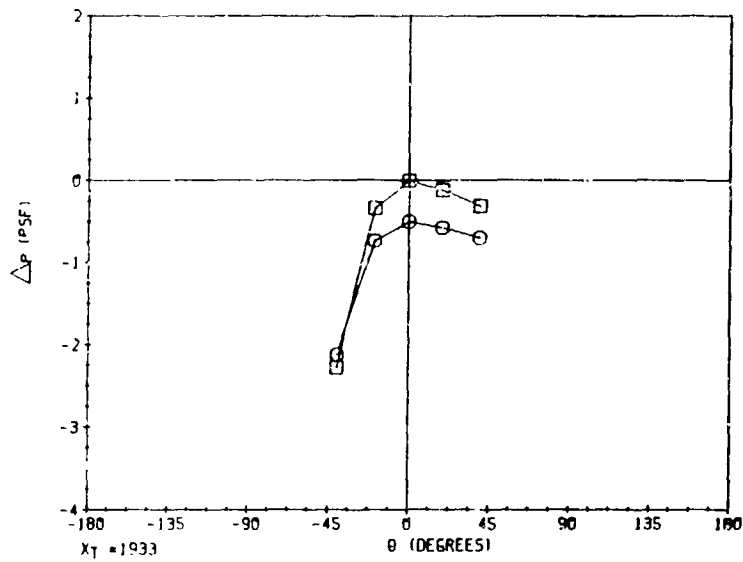
FLOWRATE EFFECTS, NO WIND

RUNS 32.1 and 32.2

V = 0 KNOTS





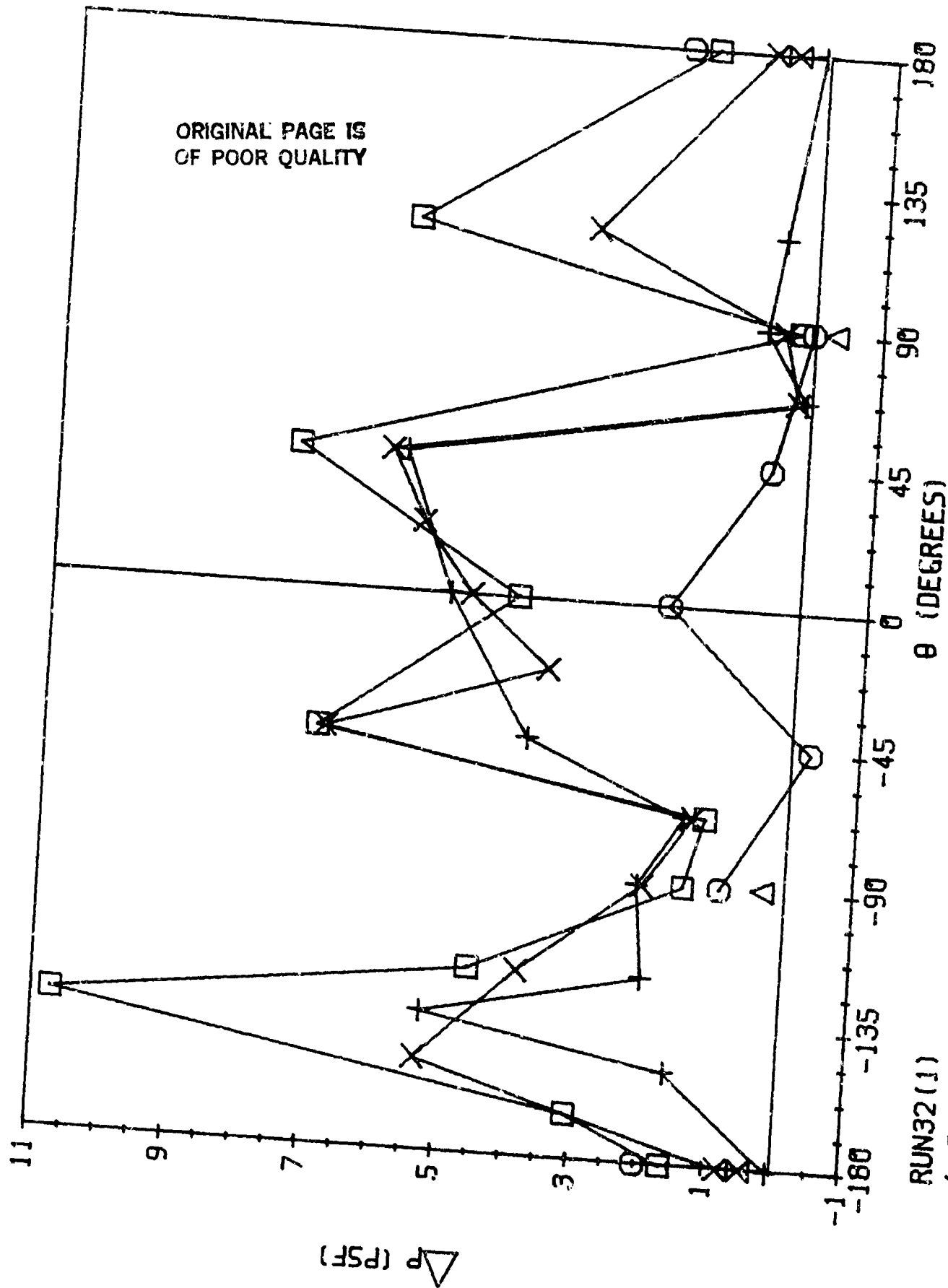


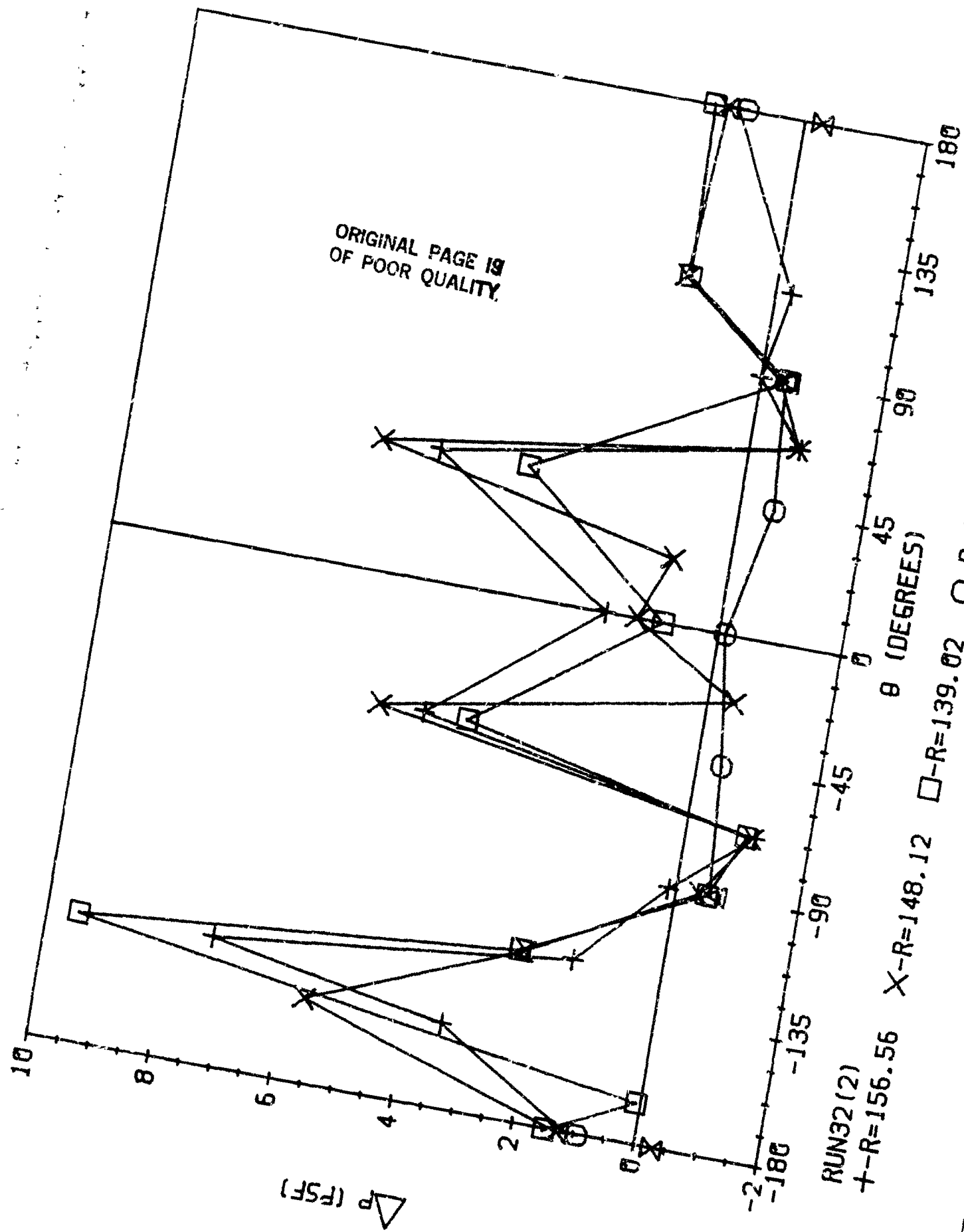
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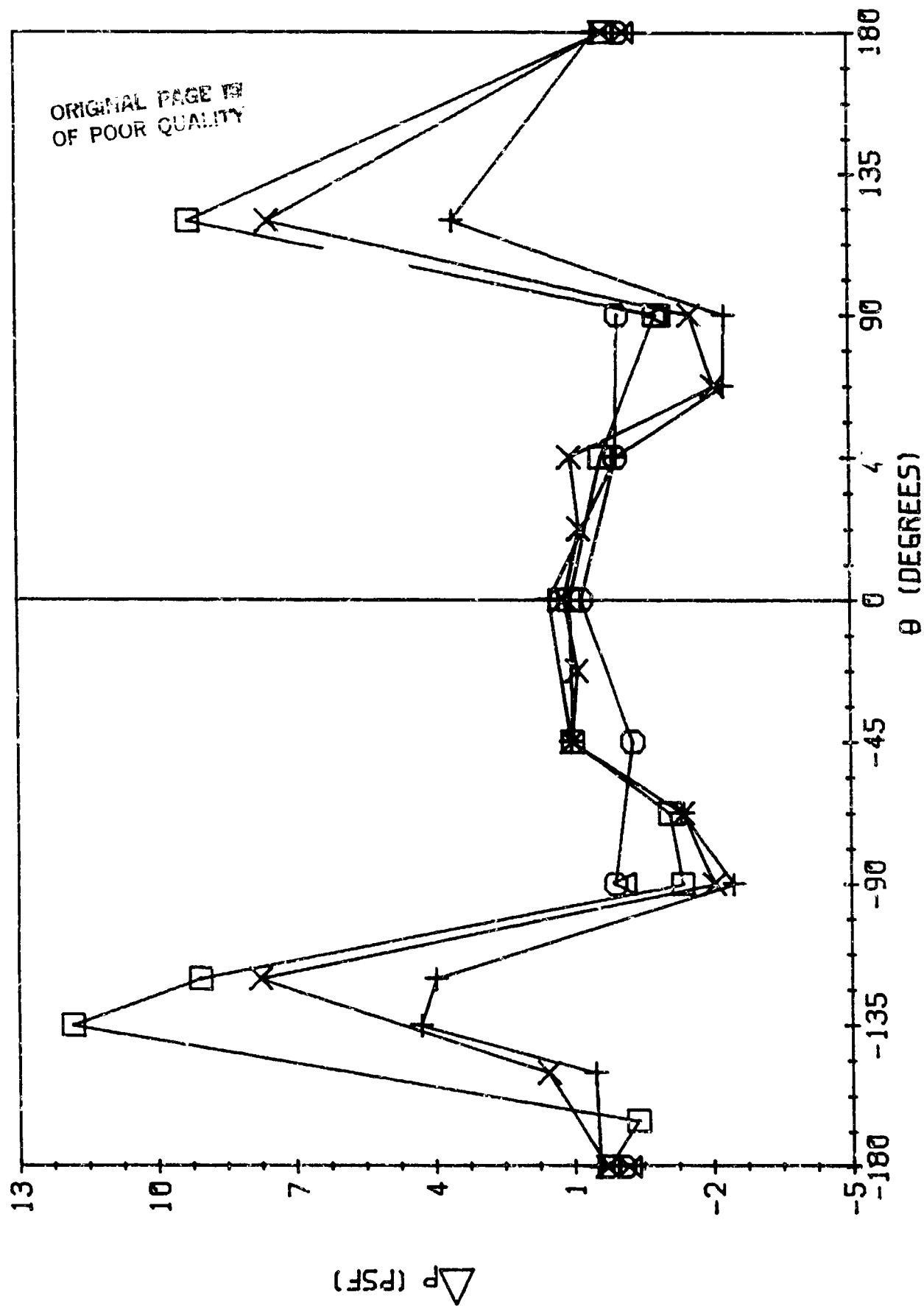
HOT FILM DATA

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

BASE PRESSURE DATA

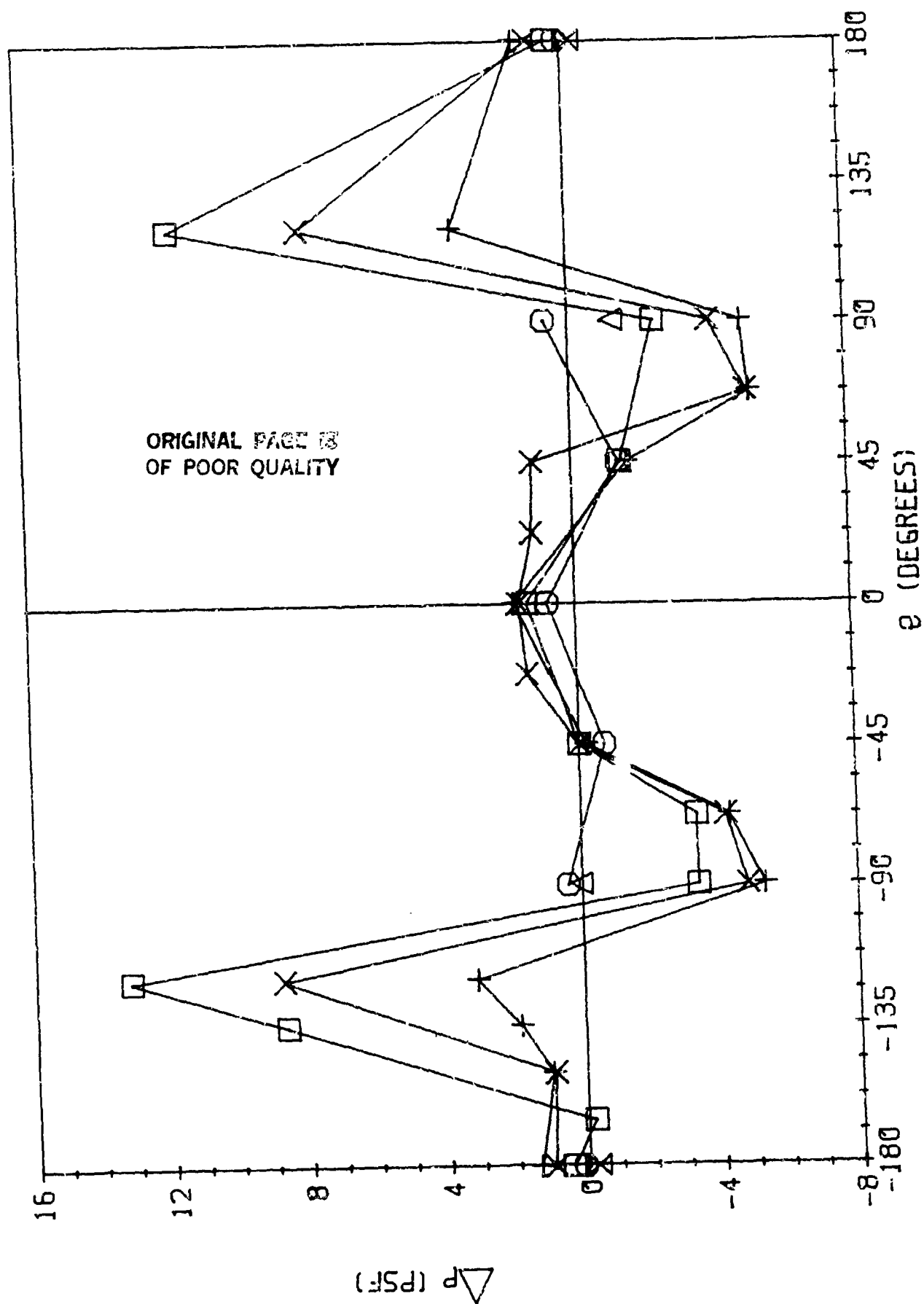






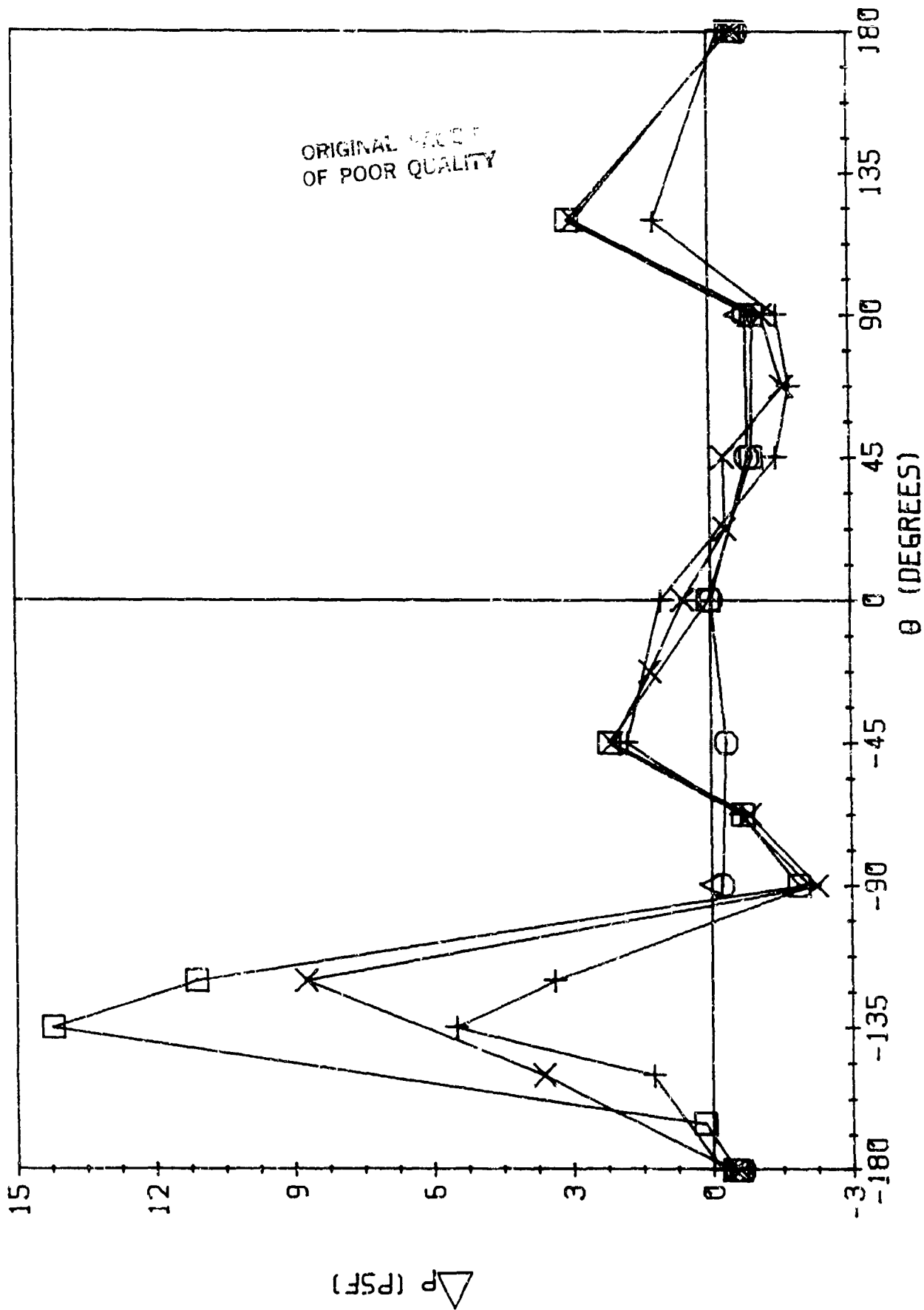
RUN33(1)

+ - R=156.56 x - R=148.12 □ - R=139.02 O - R=105.09 Δ - R=77.48 Σ - R=0



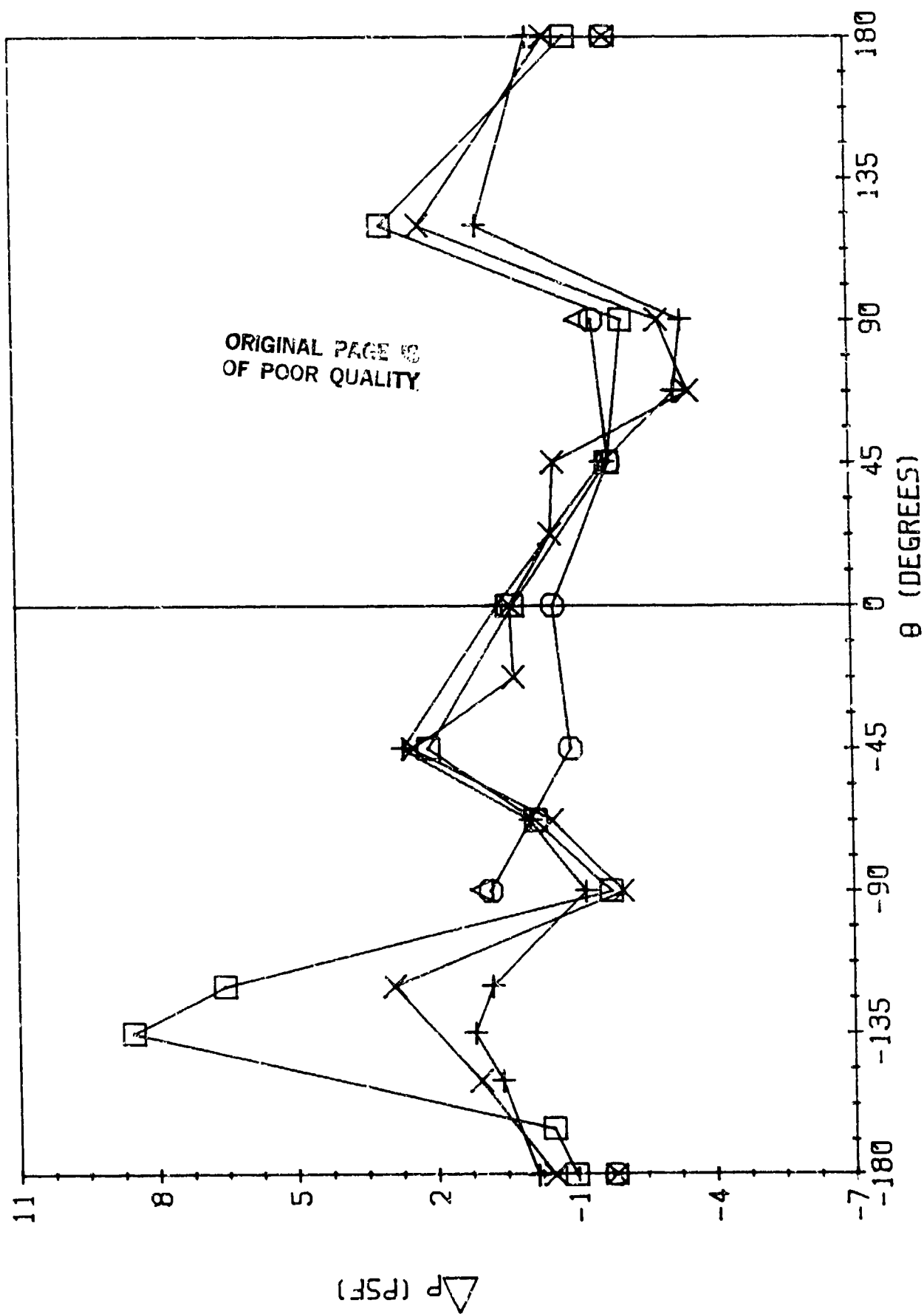
RUN33(2)

$+$ -R=156.56 x -R=148.12 \square -R=139.02 Δ -R=77.48 Σ -R=0



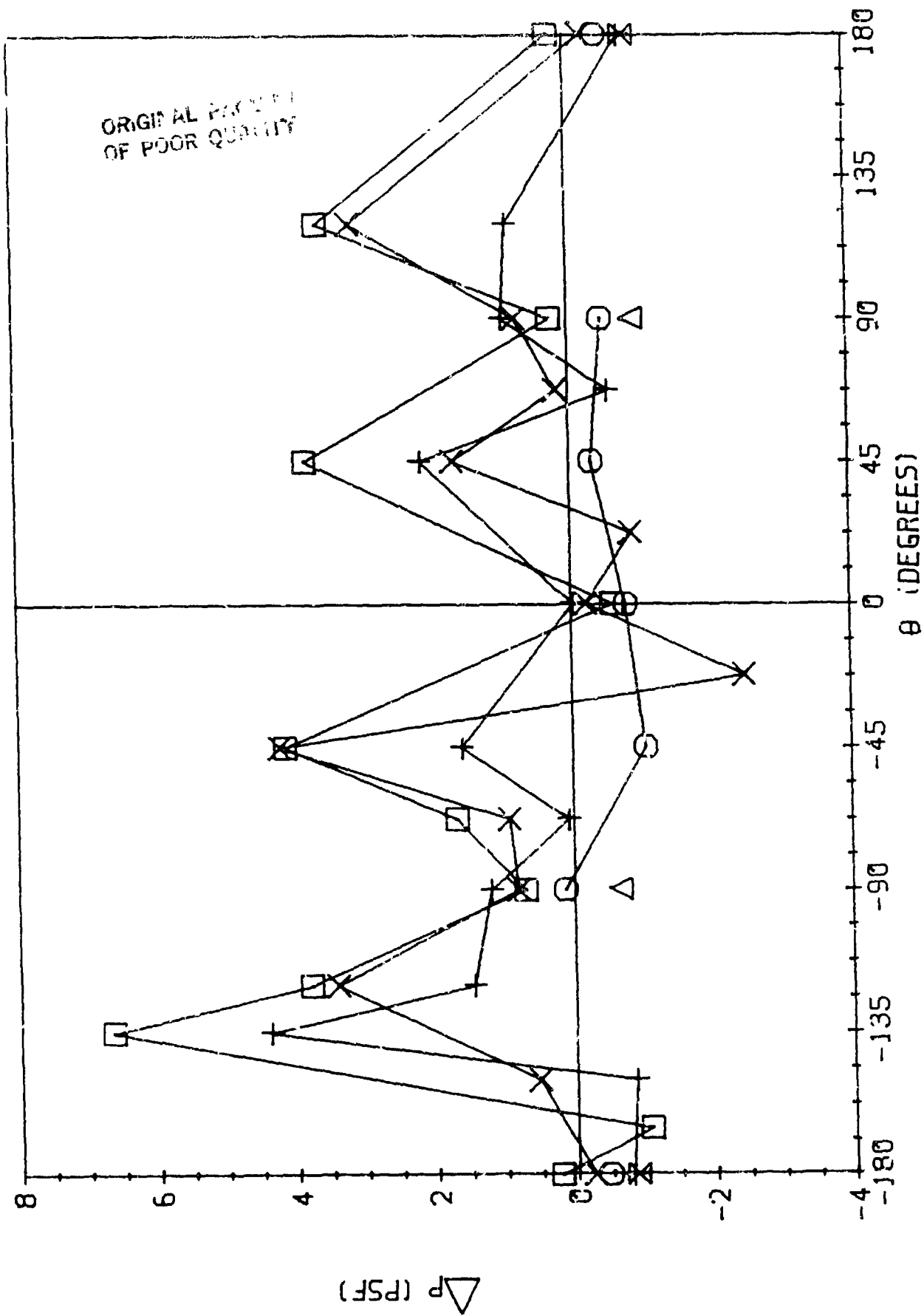
RUN34(1)

$\Delta-R=156.56$ \times - $R=148.12$ \square - $R=139.02$ \circ - $R=105.09$ \triangle - $R=77.48$ \boxtimes - $R=0$



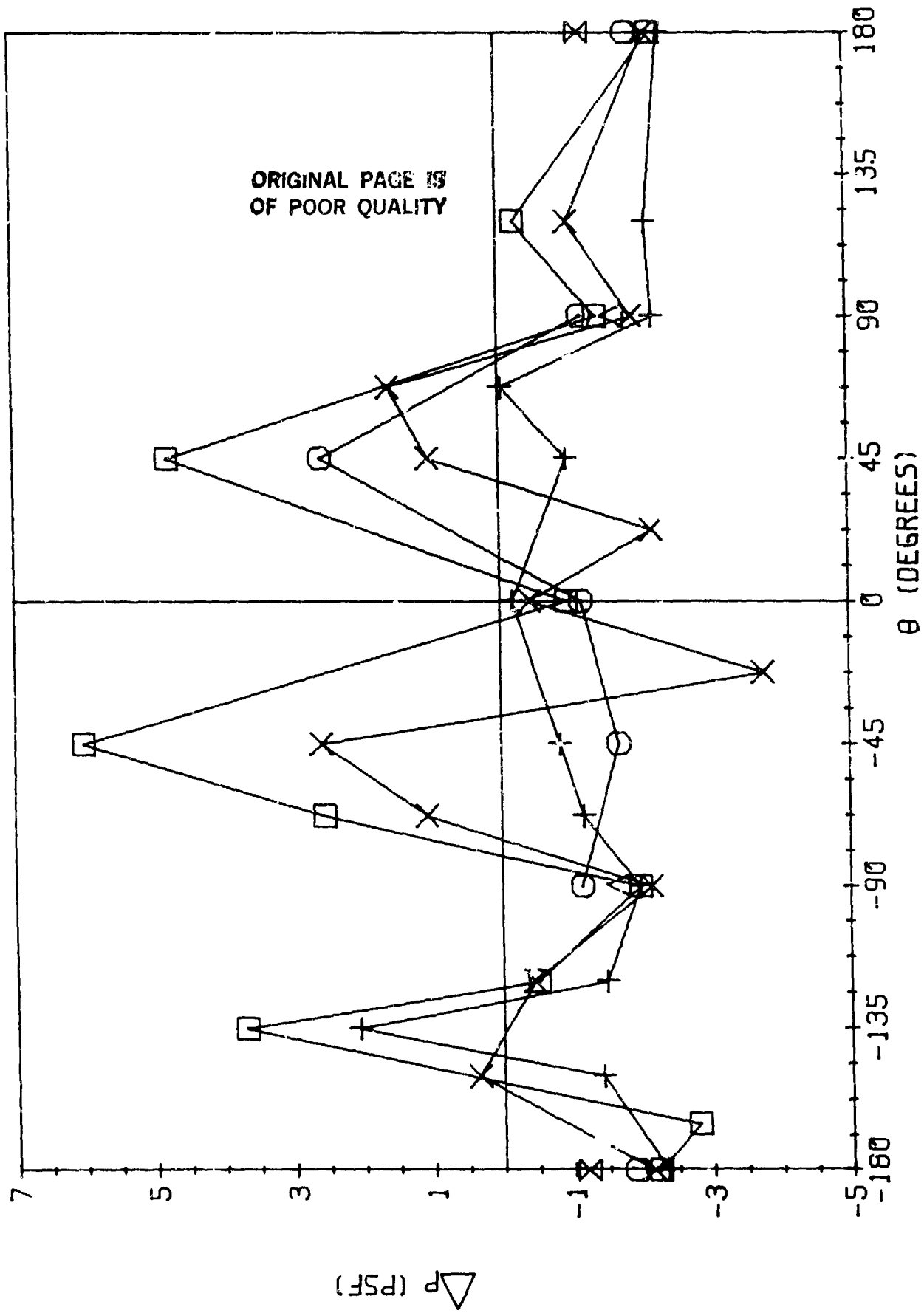
RUN34(2)

+ - R=156.56 x - R=148.12 \square - R=139.02 Δ - R=105.09 Δ - R=77.48 Σ - R=0



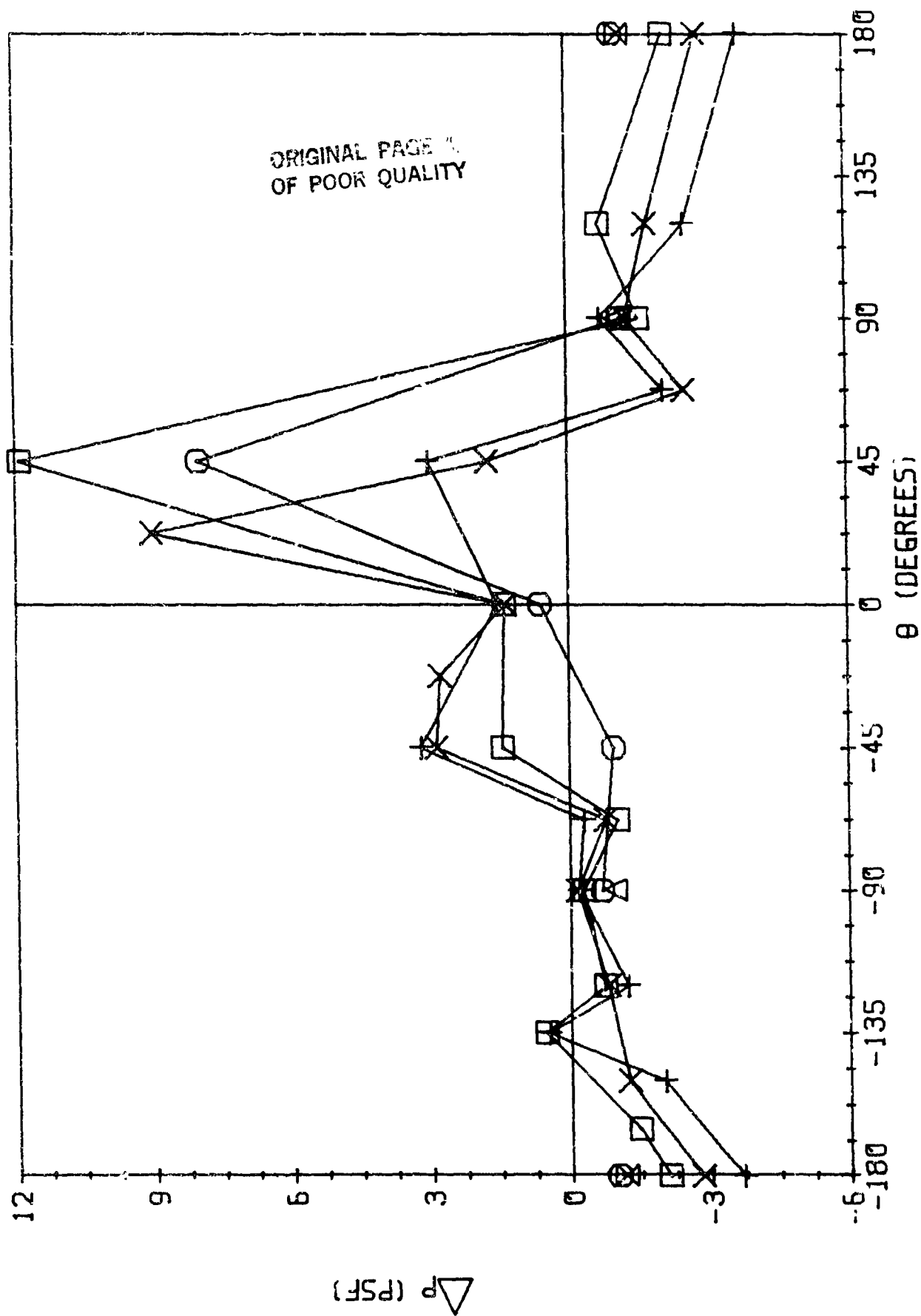
RUN35(11)

\square -R=148.12 \times -R=156.56 \circ -R=105.09 Δ -R=77.48 Σ -R=0



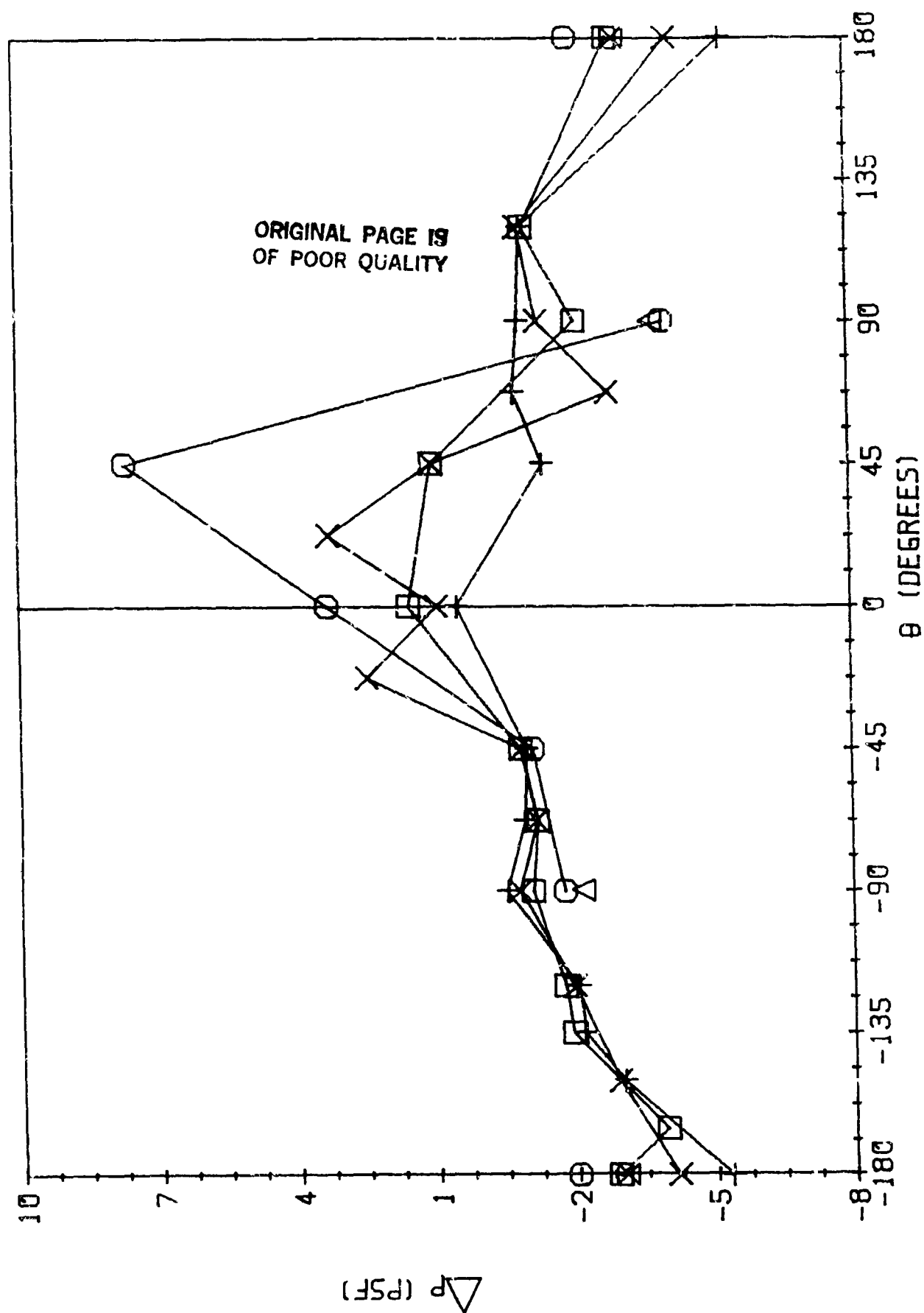
RUN35(2)

\triangle -R=156.56 \times -R=148.12 \square -R=139.02 \circ -R=105.09 \triangle -R=77.48 \times -R=0



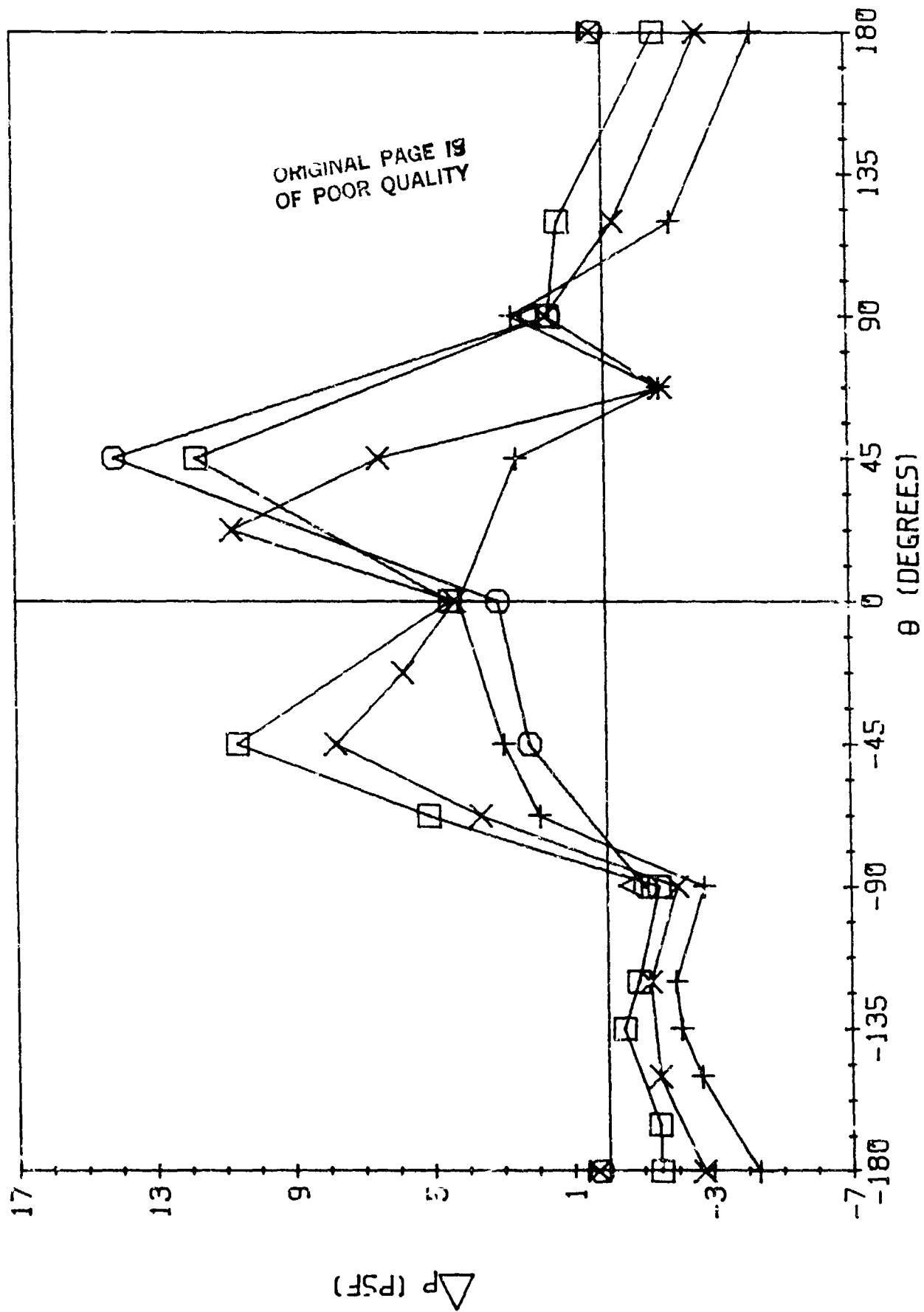
RUN36(1)

+--R=156.56 x--R=148.12 □--R=139.02 O--R=105.09 Δ--R=77.48 X--R=0



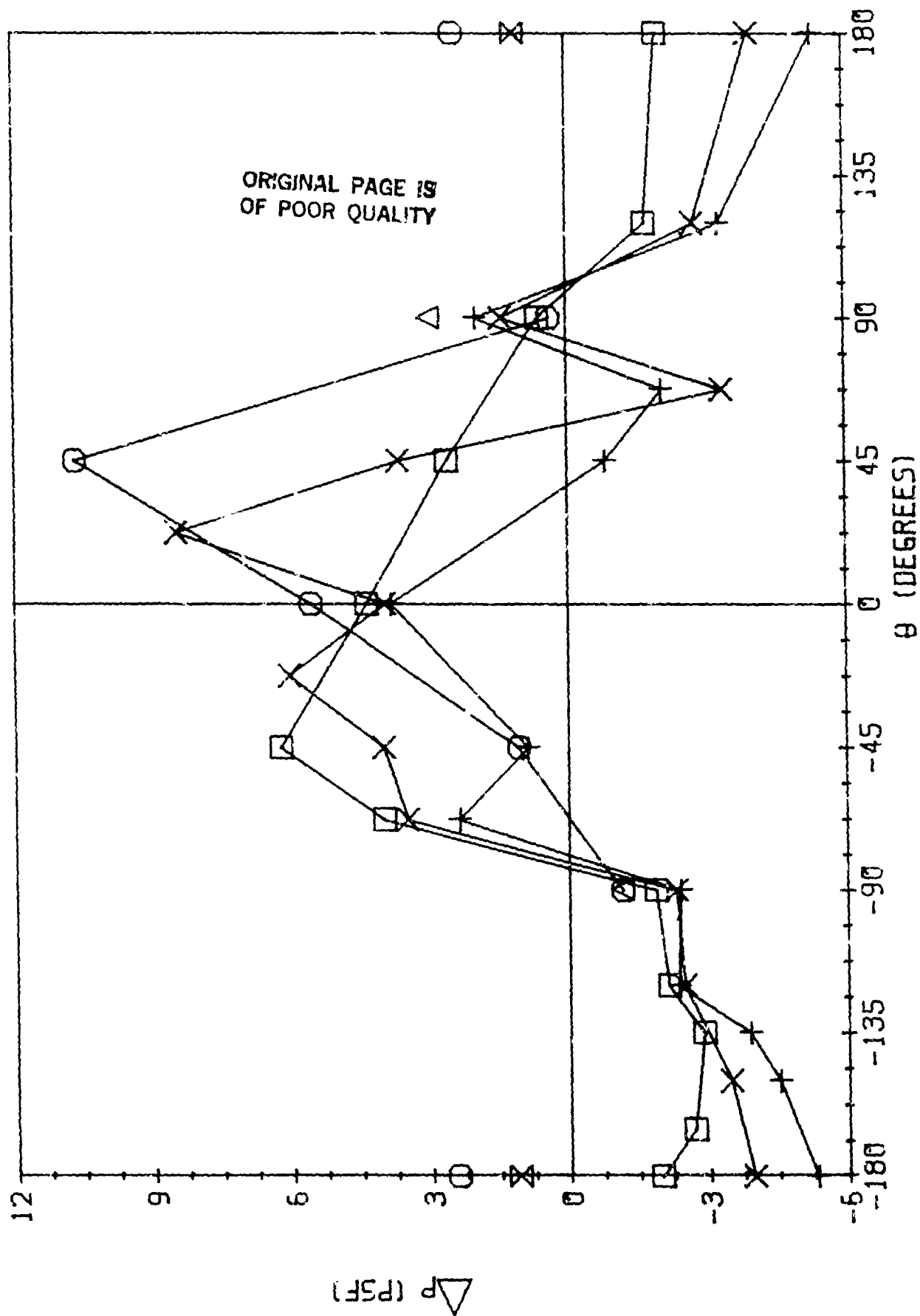
RUN36 (2)

$\Delta-R=156.56$ $\times-R=148.12$ $\square-R=139.02$ $\circ-R=105.09$ $\Delta-R=77.48$ $\Sigma-R=0$



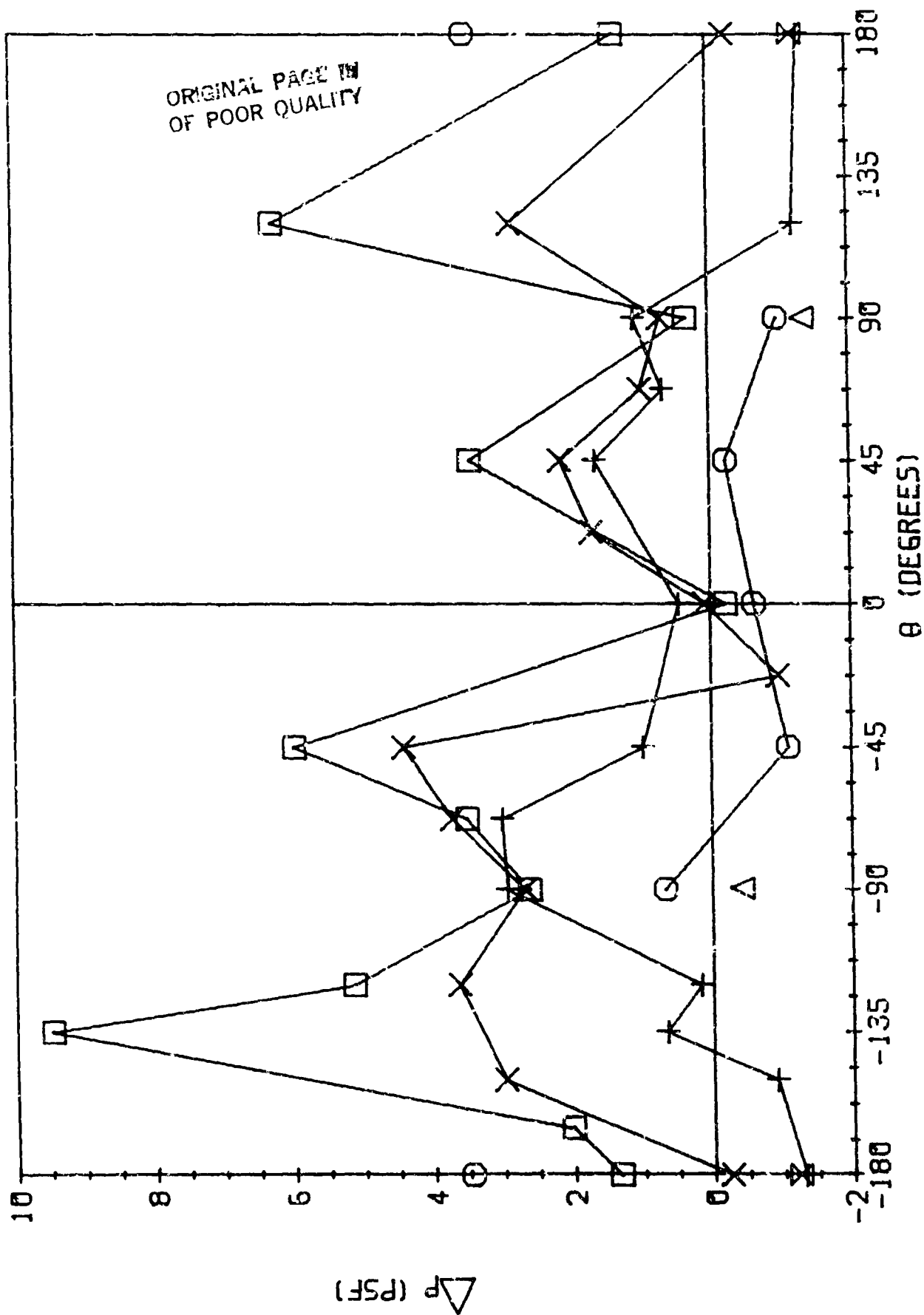
RUN37(1)

+ - R=156.56 x - R=148.12 □ - R=139.02 Δ - R=77.48



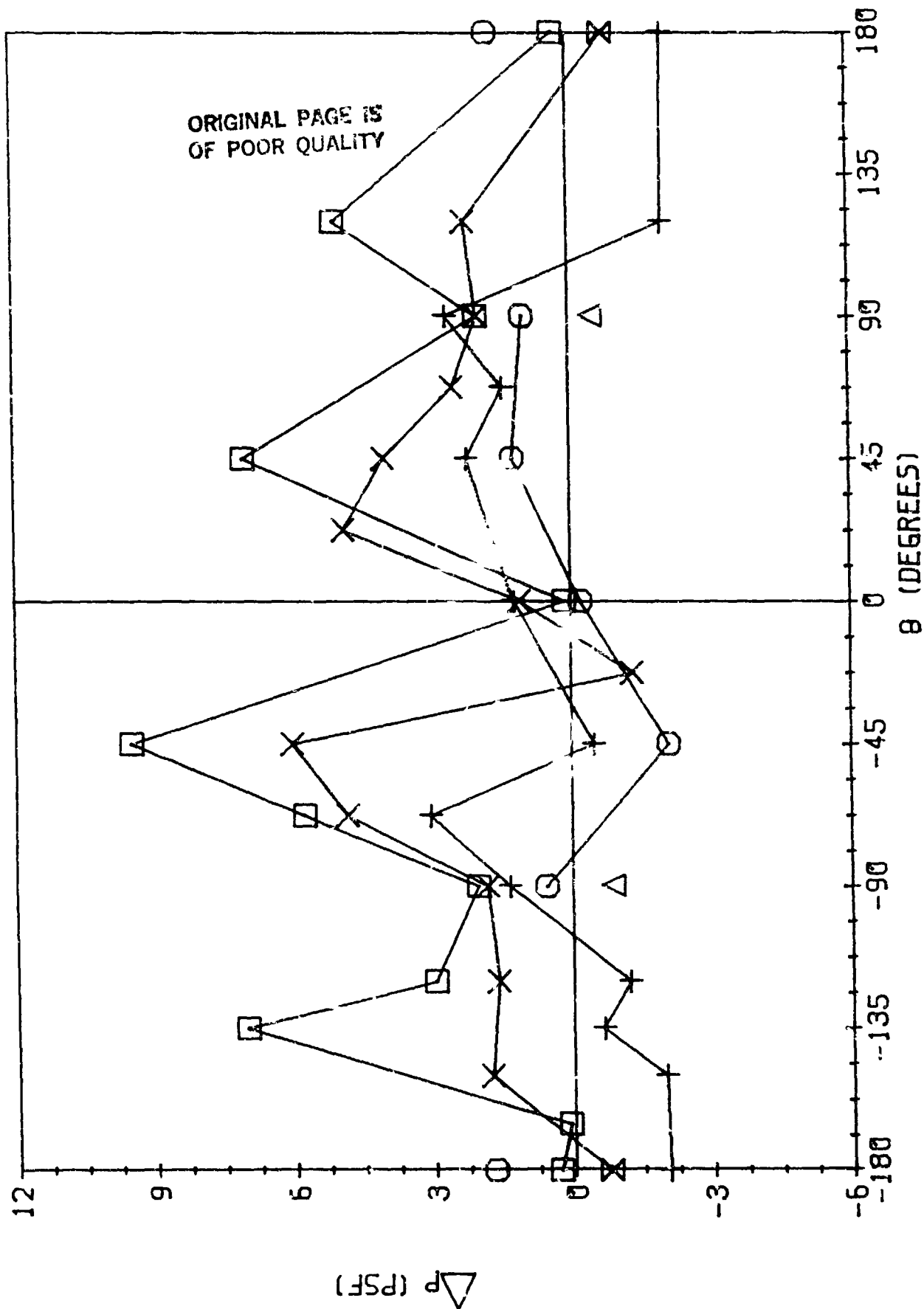
RUN37(2)

θ -R=156.56 \times -R=148.12 \square -R=139.82 Δ -R=77.48 \times -R=0



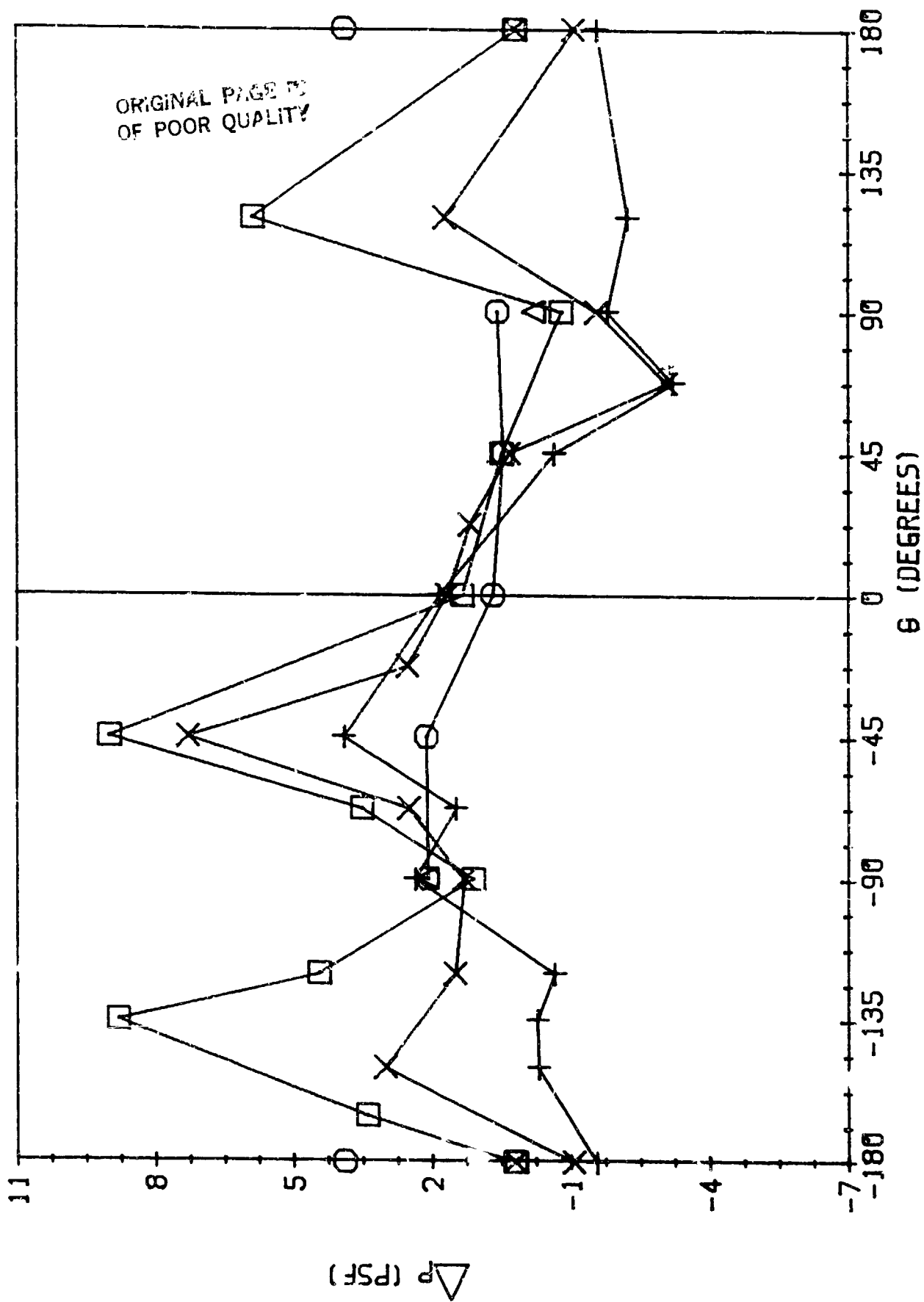
RUN38(1)

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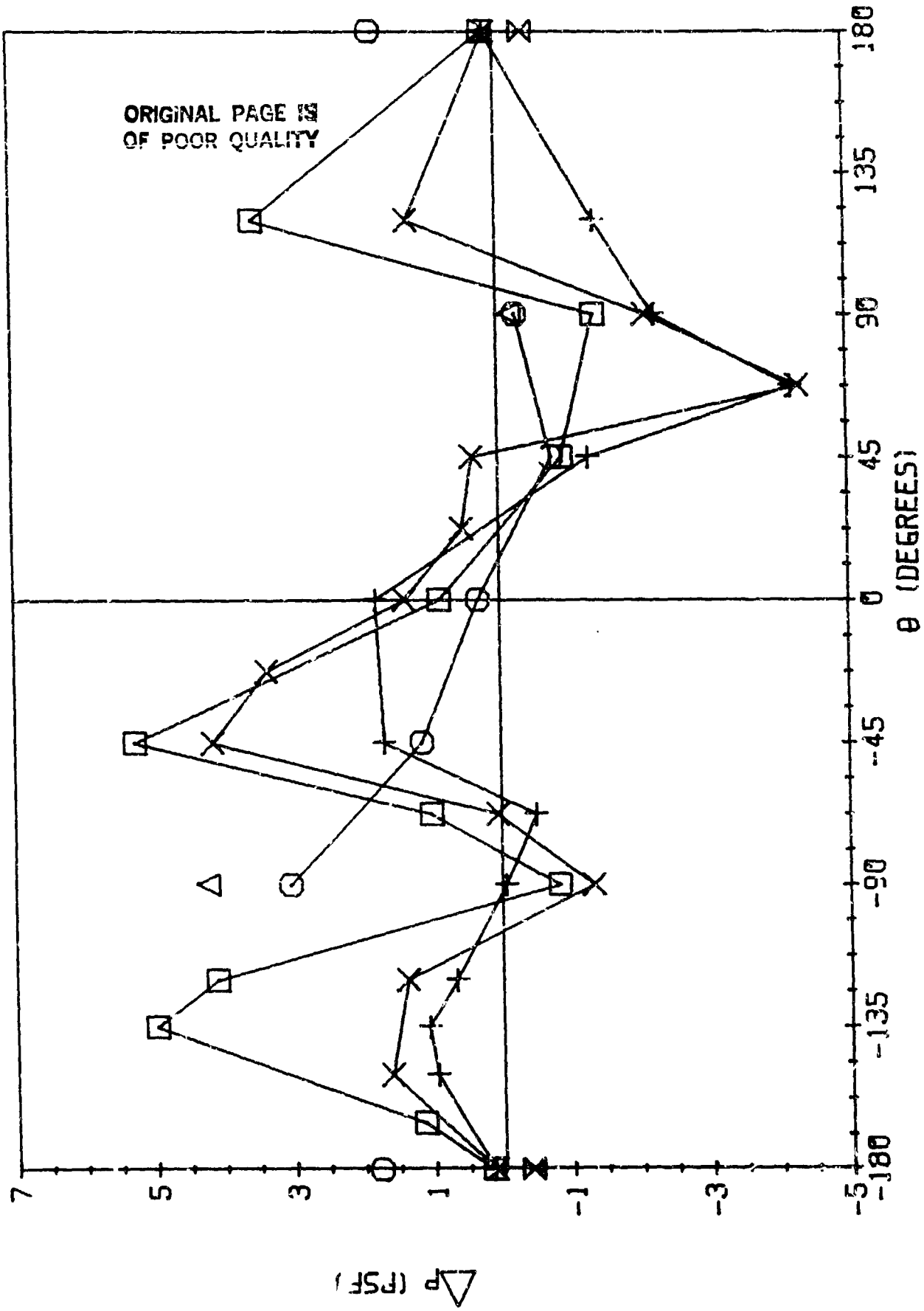
RUN38(2)

$+$ -R=155.56 \times -R=148.12 \square -R=139.02 \circ -R=105.09 \triangle -R=77.48 Σ -R=0



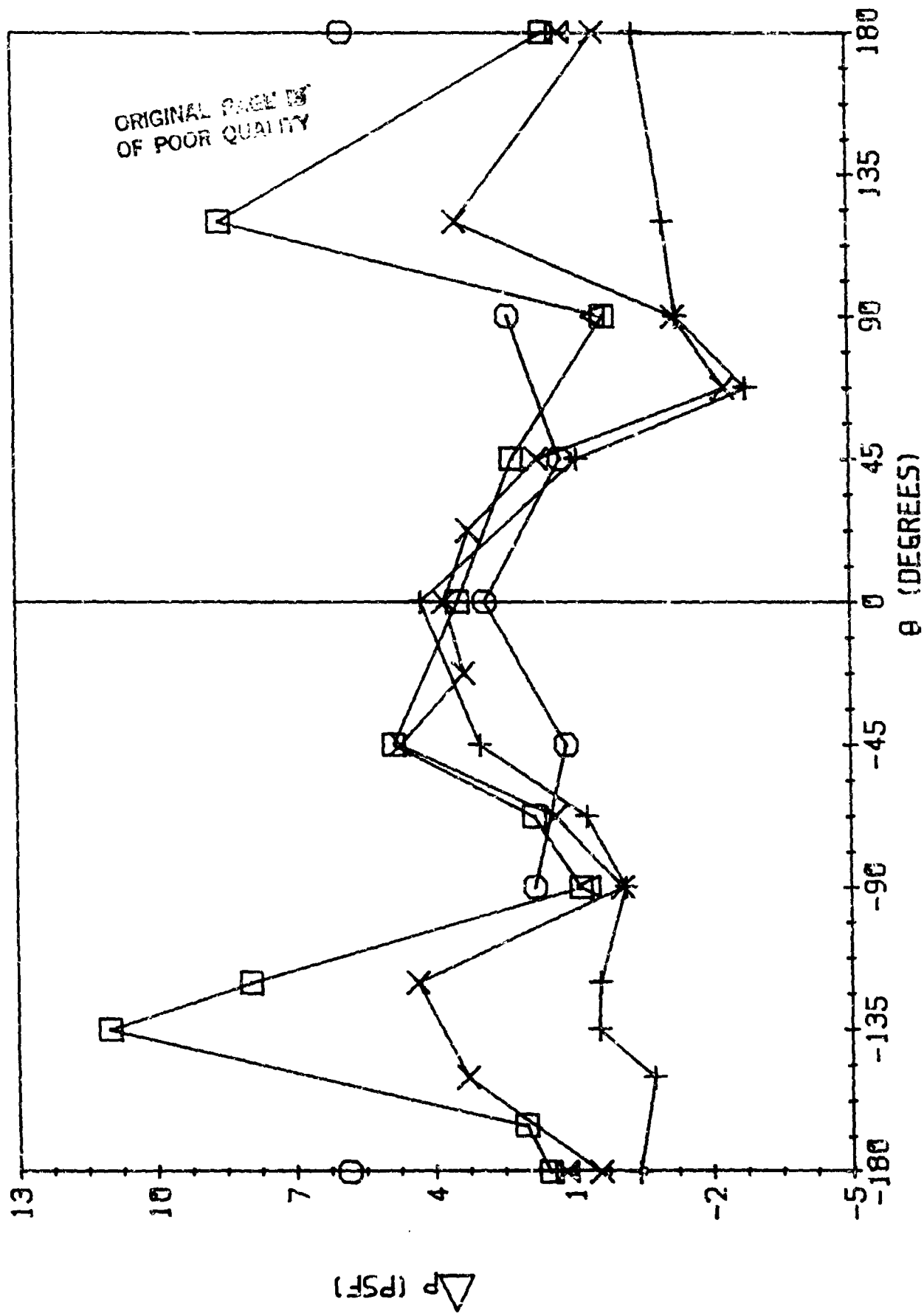
RUN39(1)

+ - R=156.56 x - R=148.12 □ - R=139.02 Δ - R=77.48 Σ - R=0

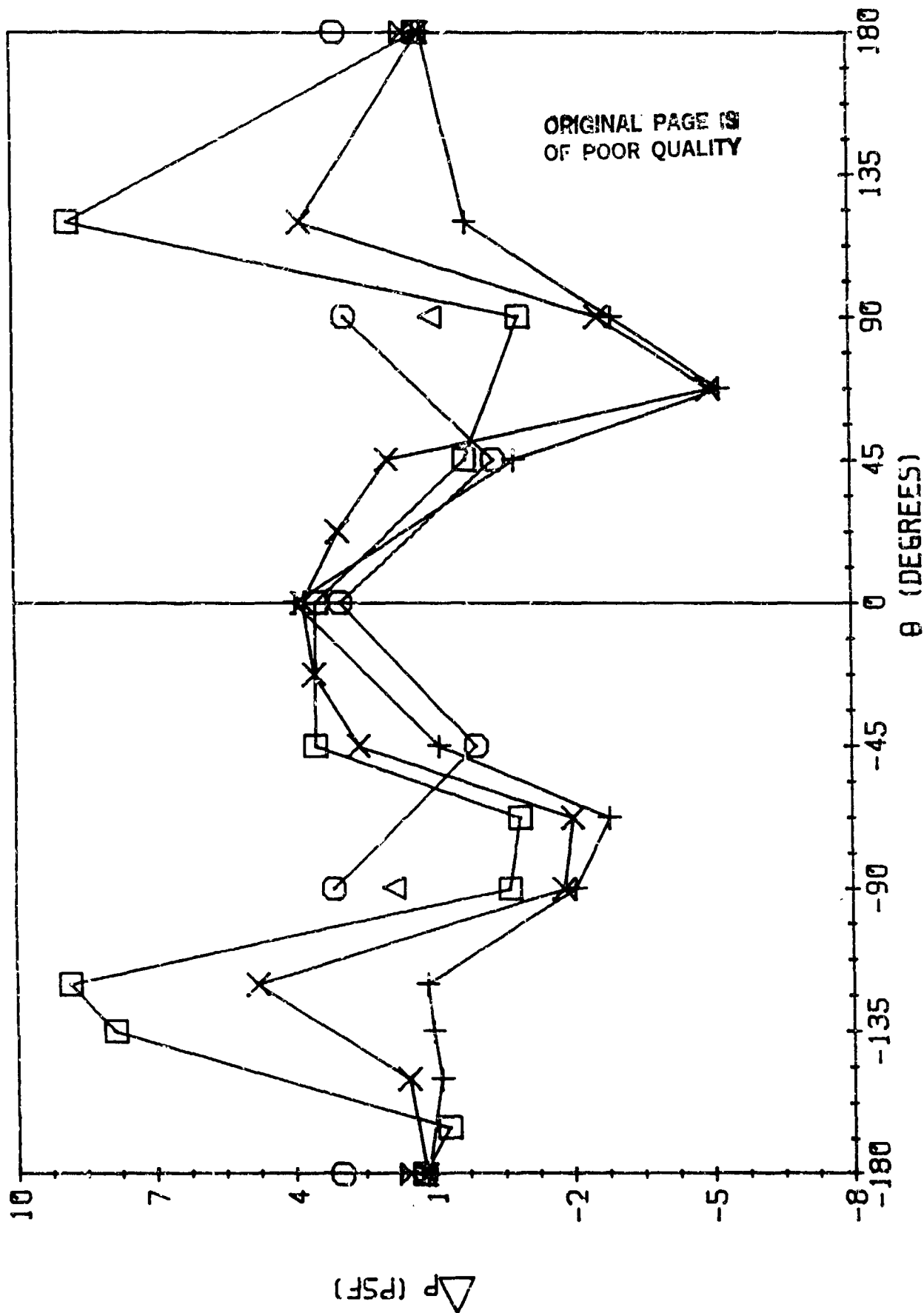


RUN39(2)

+R=156.56 X-R=148.12 \square -R=139.02 O-R=105.09 Δ -R=77.48 X-R=0



RUN40(11)
 $+-R=156.56$ $\times-R=148.12$ $\square-R=139.02$ $\Delta-R=105.09$ $\Delta-R=77.48$ $\Sigma-R=0$



RUN40(2)

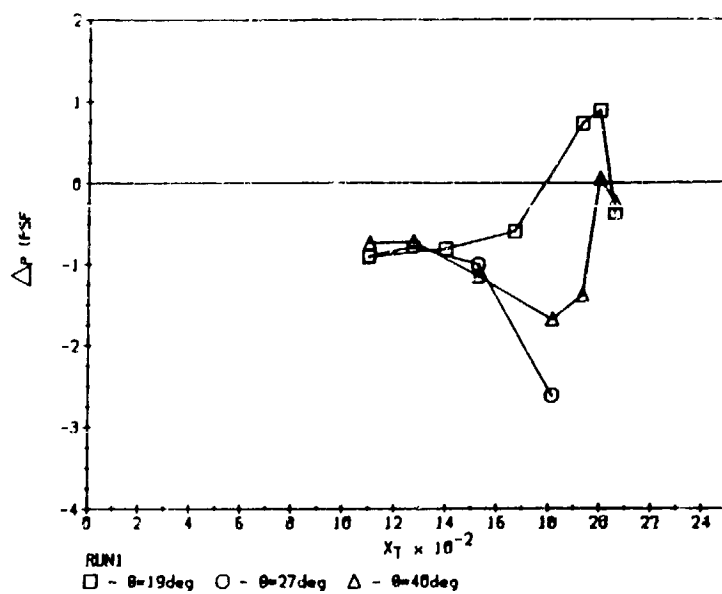
+ - R=156.56 X - R=148.12 □ - R=139.02 O - R=105.09 Δ - R=77.48 Σ - R=0

FEEDLINE AND CABLE TRAY

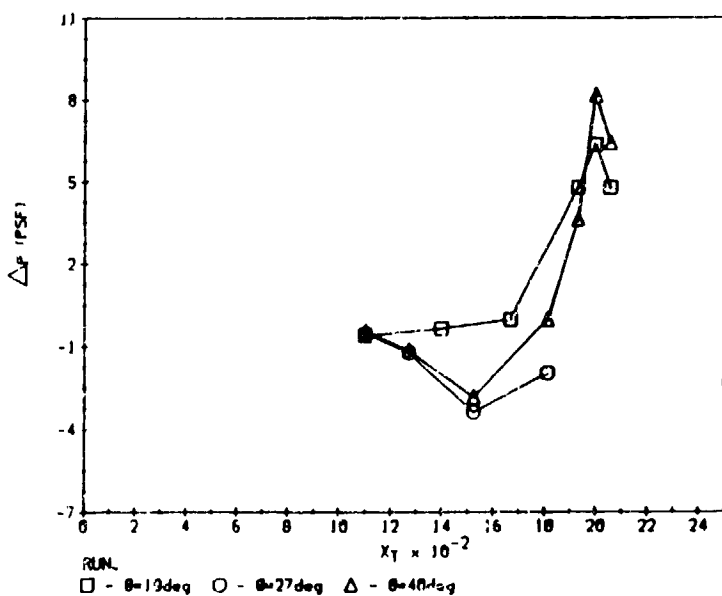
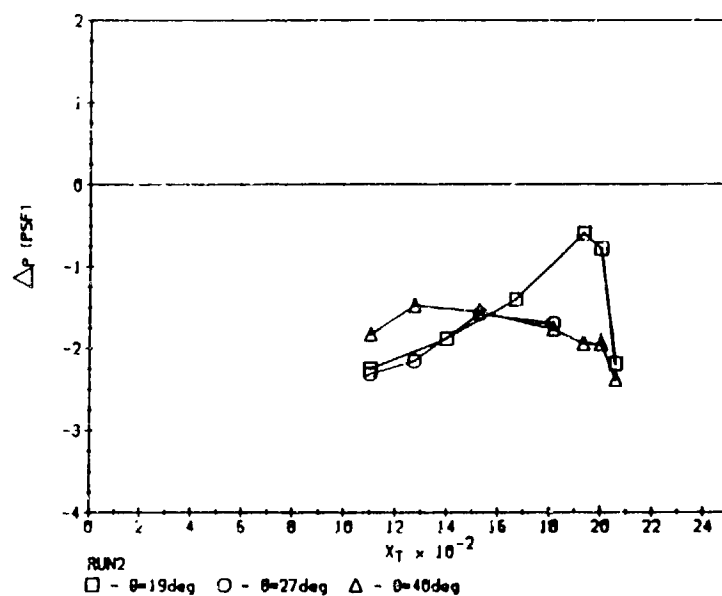
PRESSURE DATA

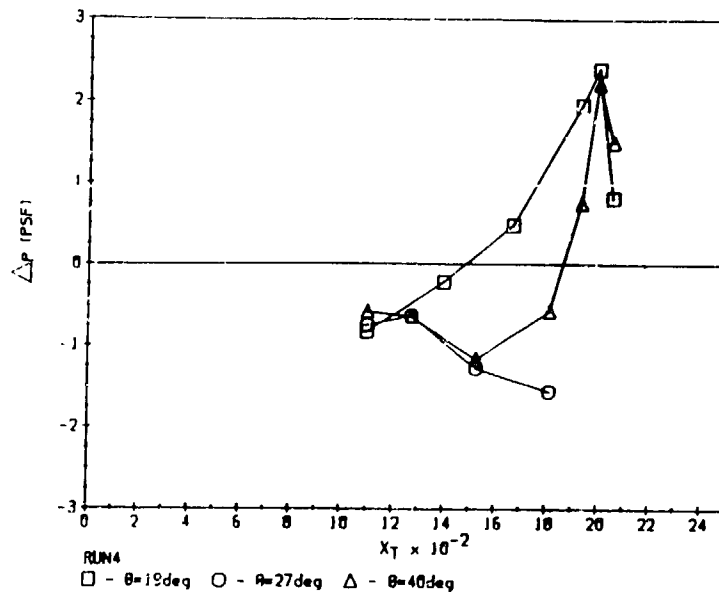
ALL CONFIGURATIONS

ALL RUNS

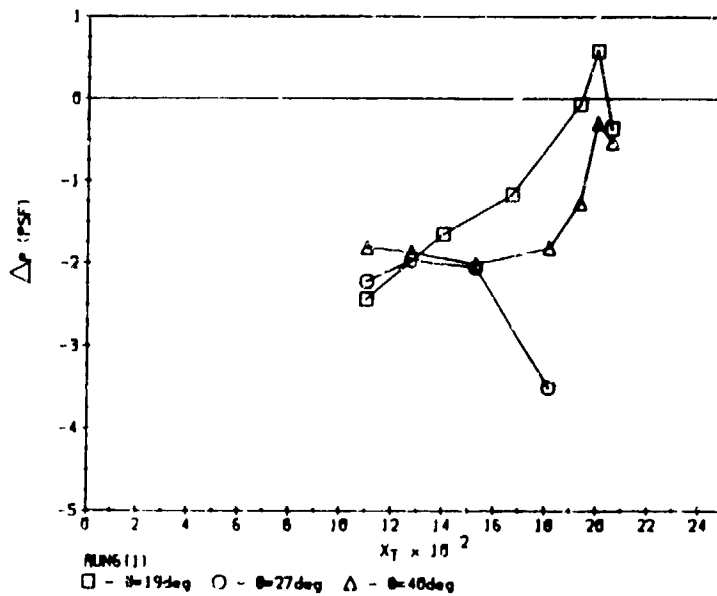
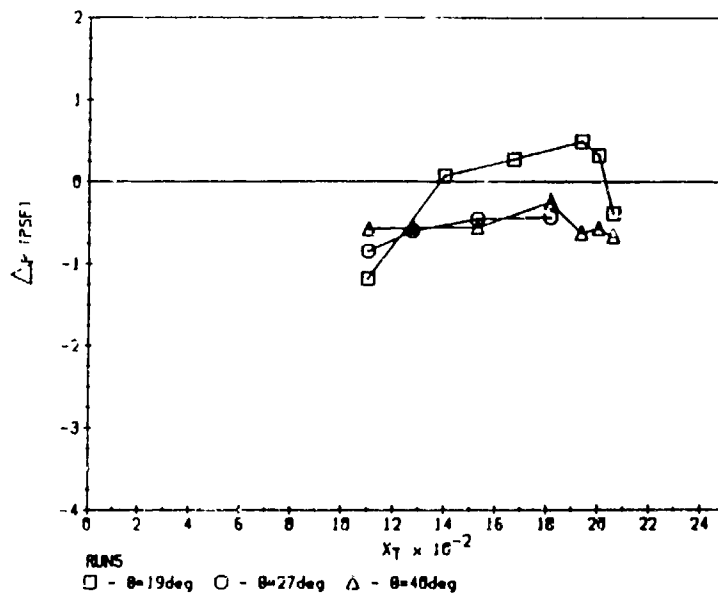


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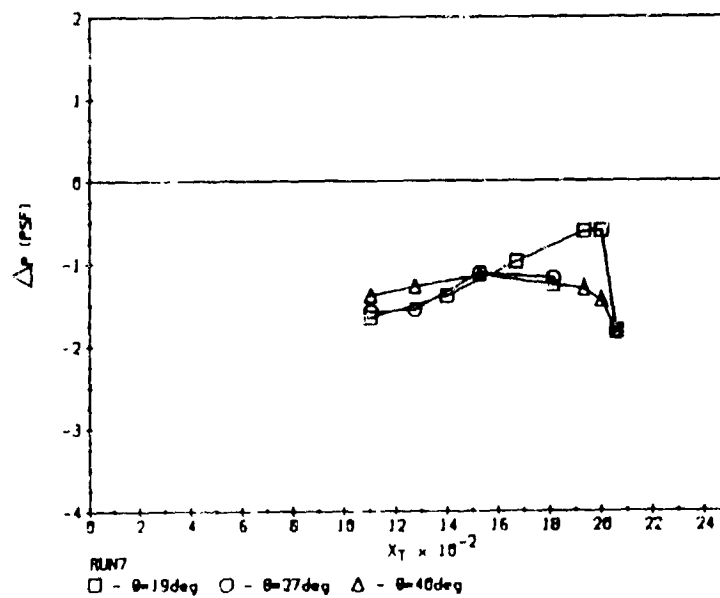
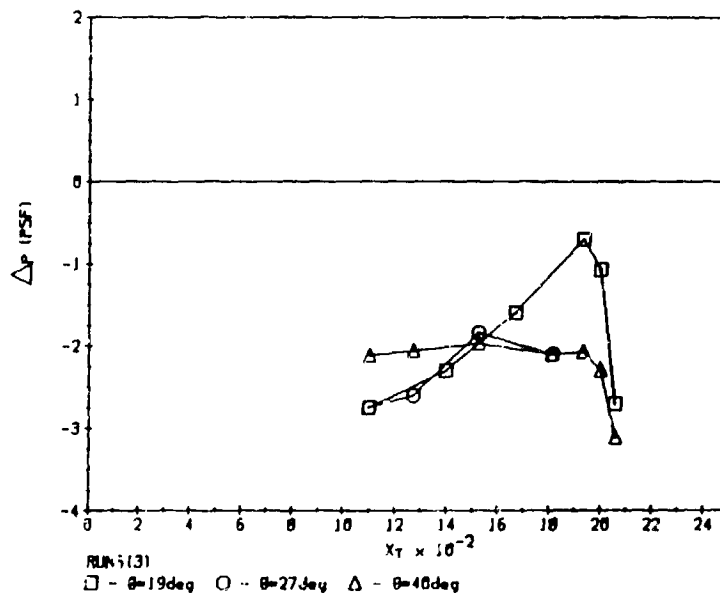
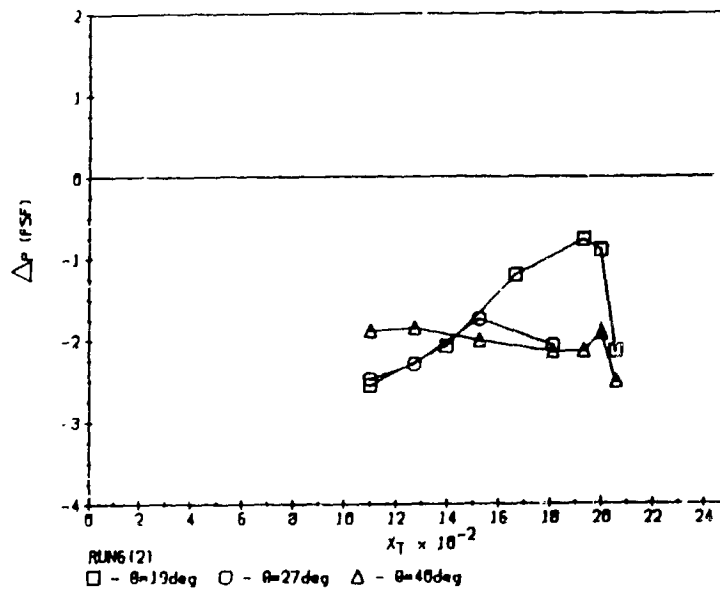


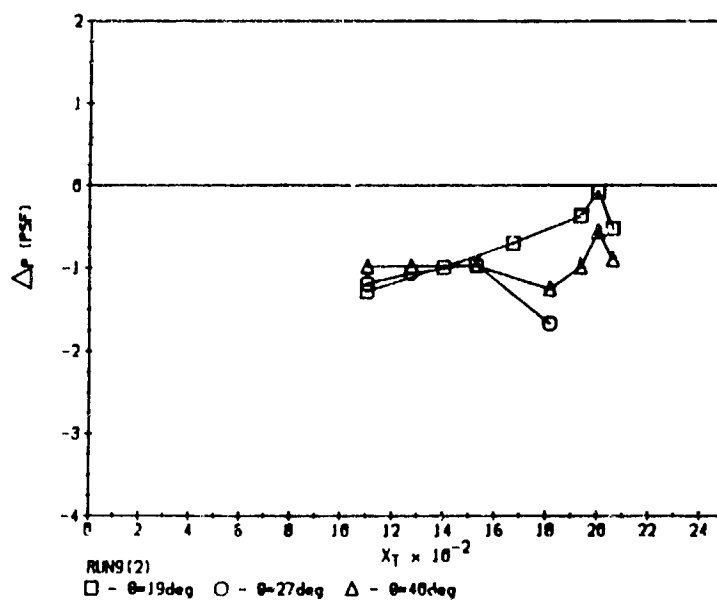
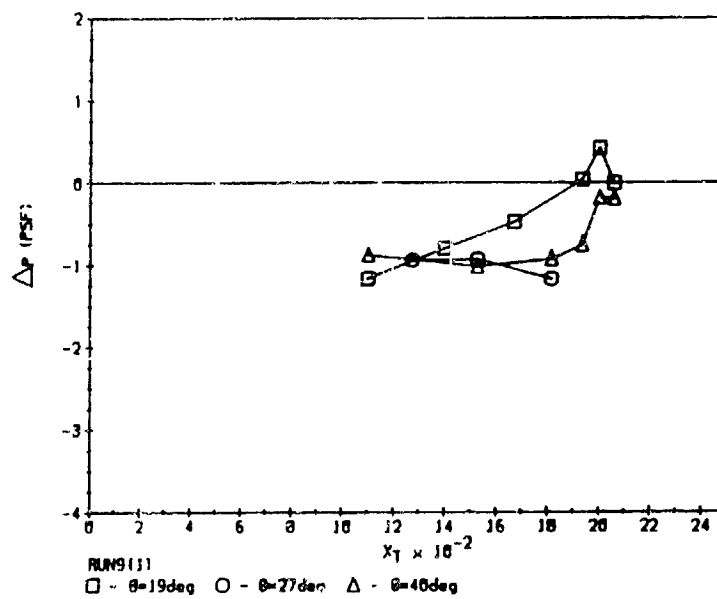
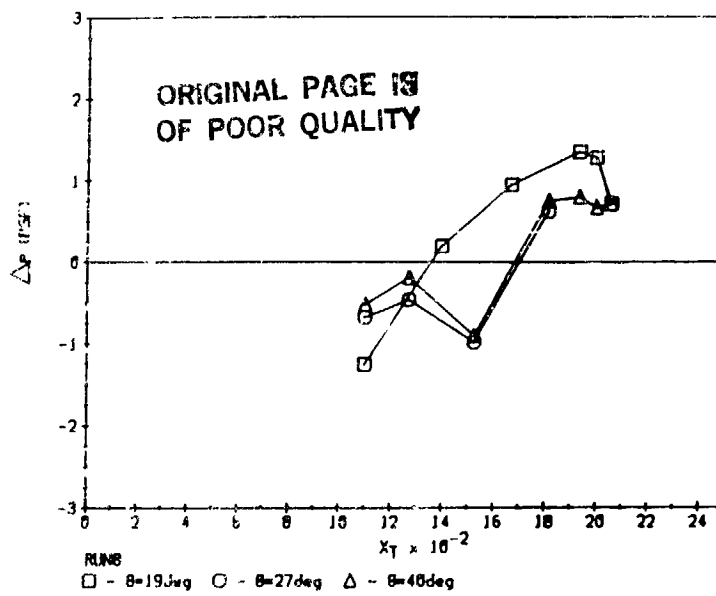


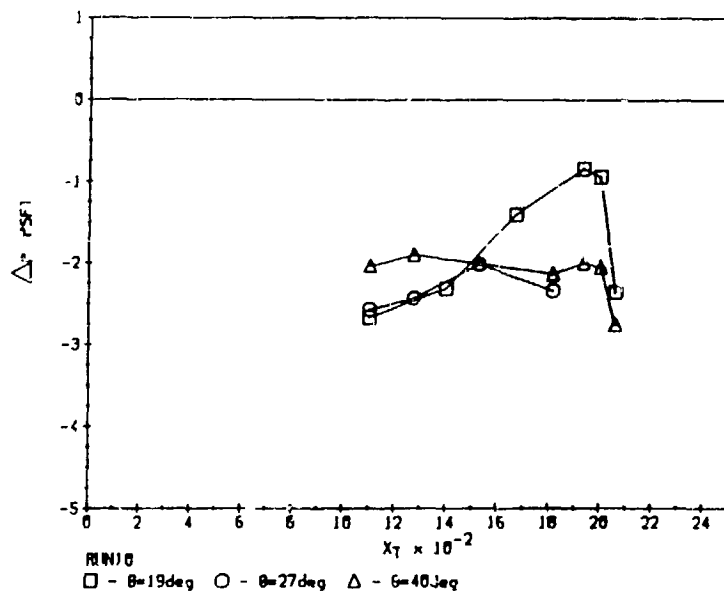
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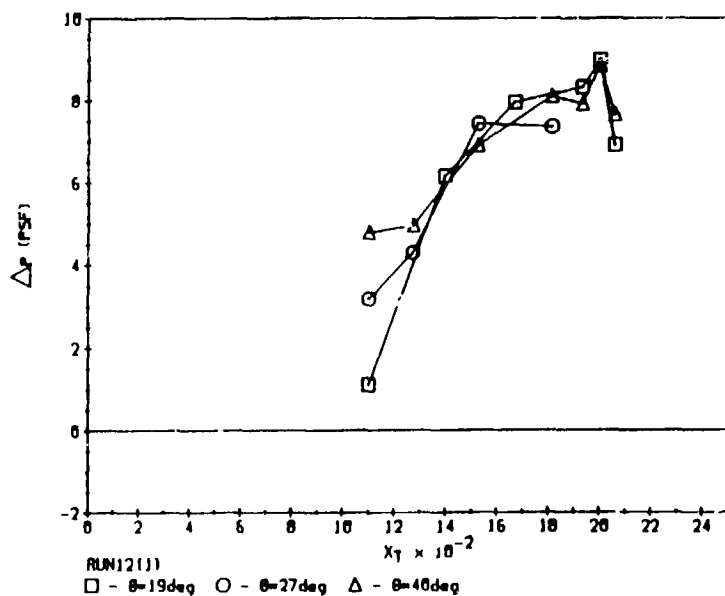
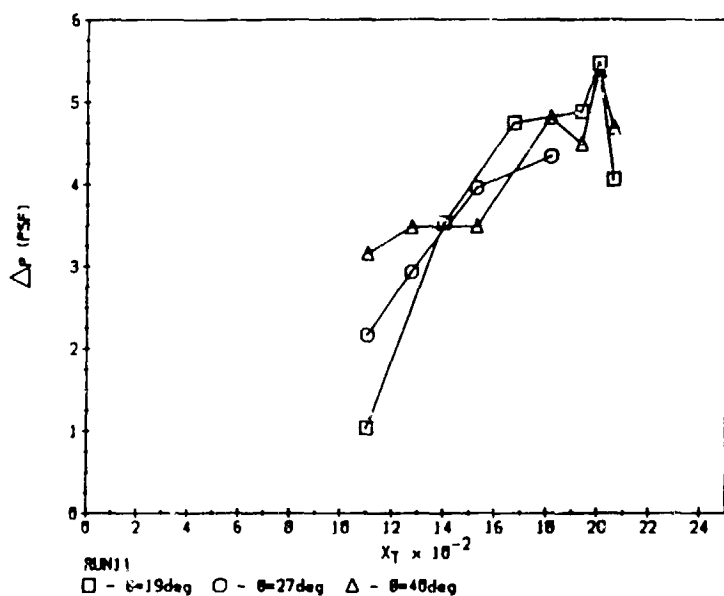
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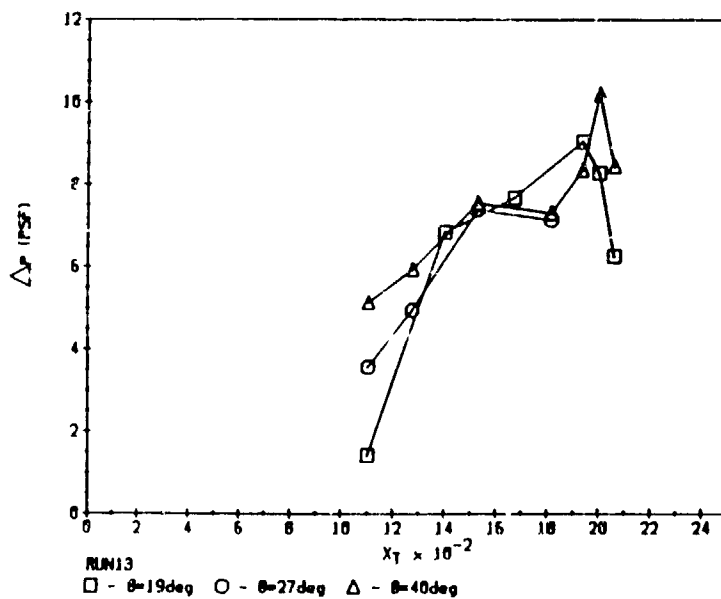
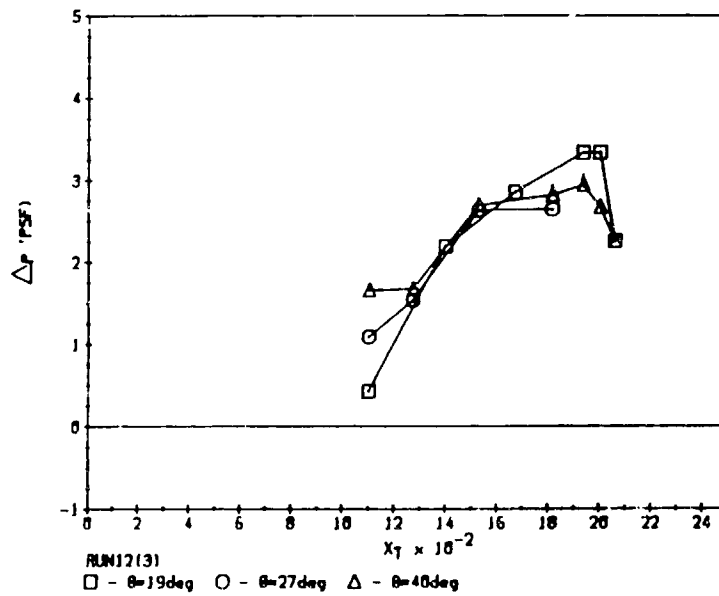
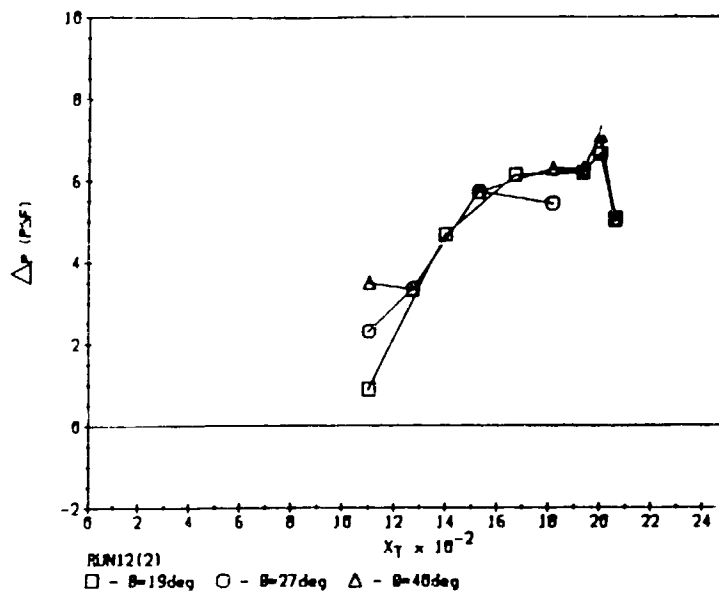




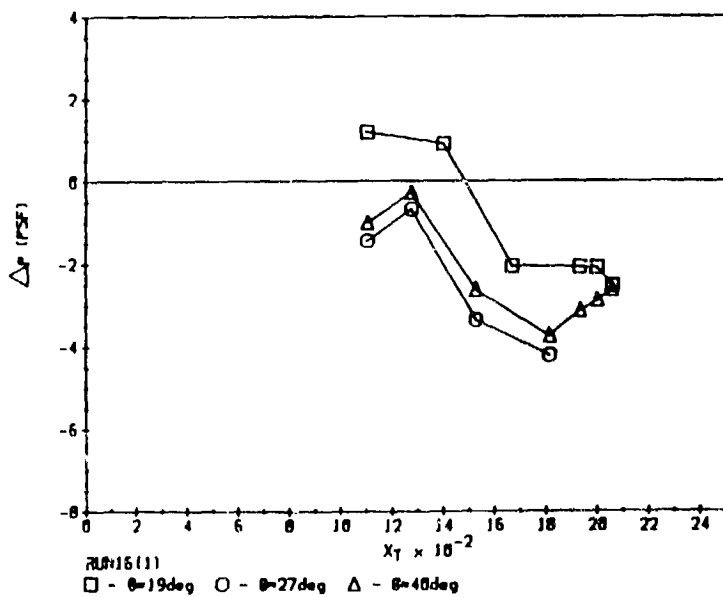
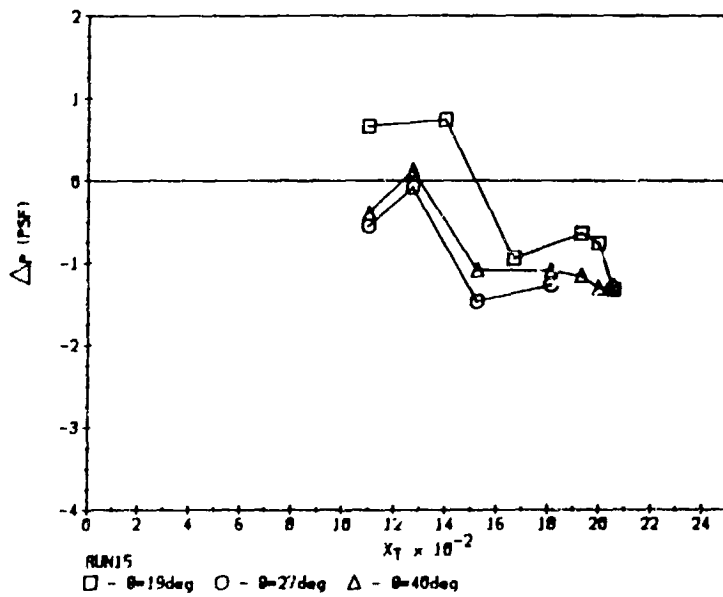
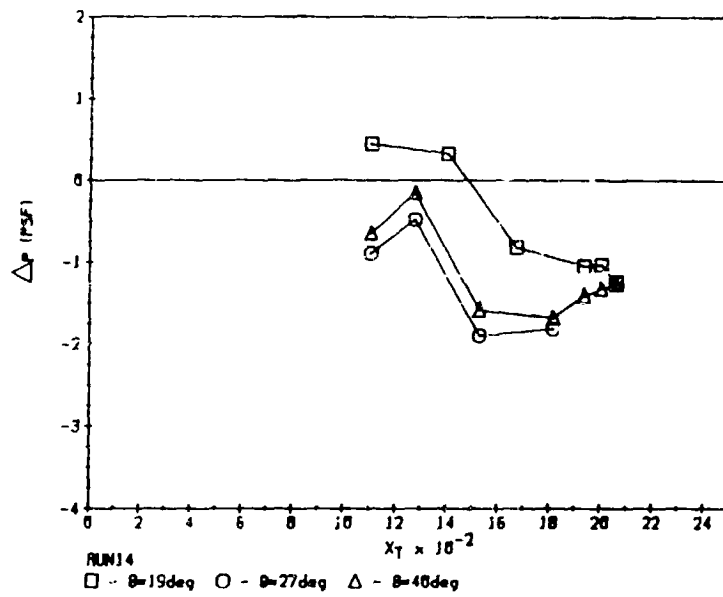
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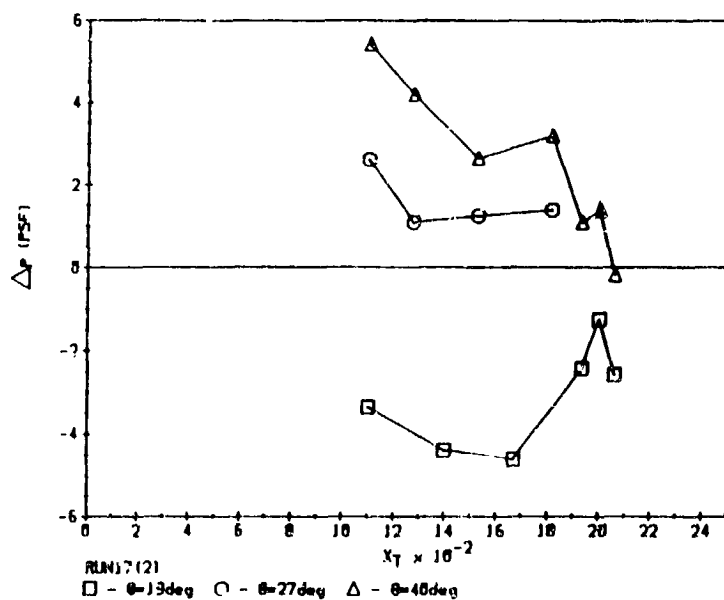
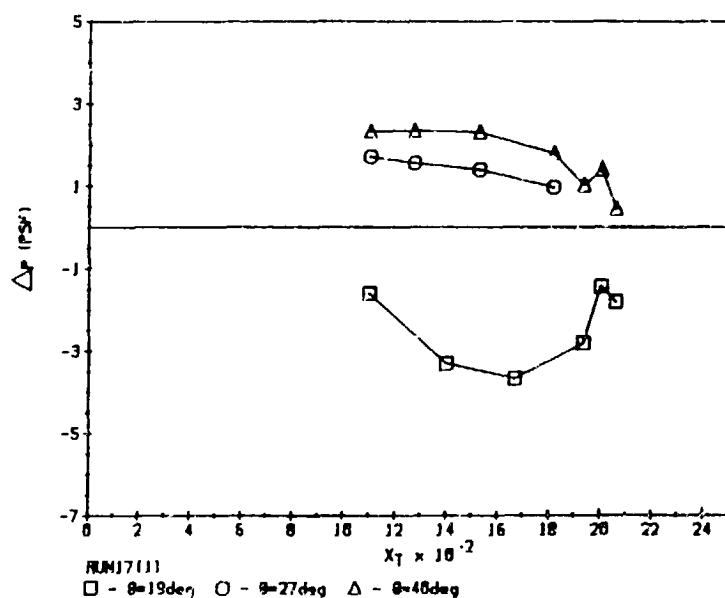
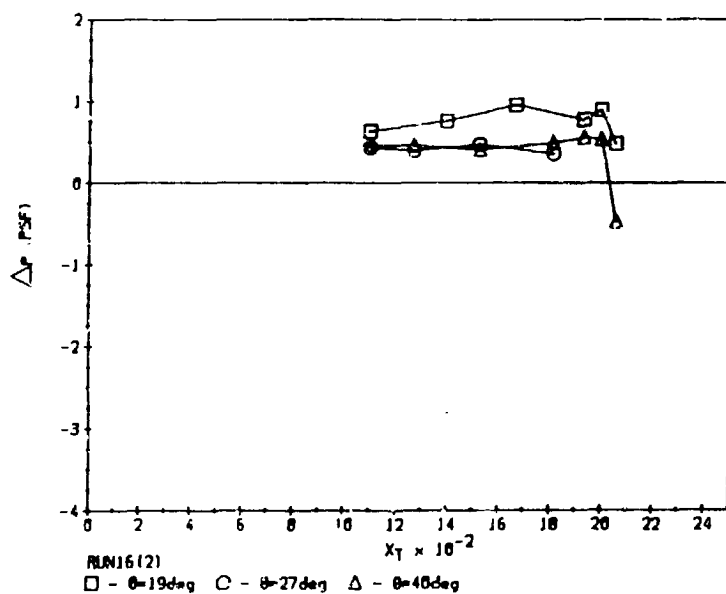
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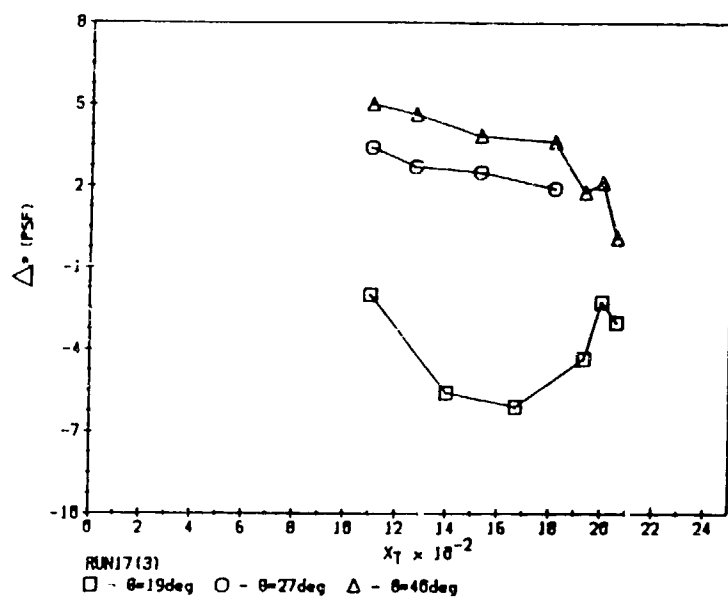


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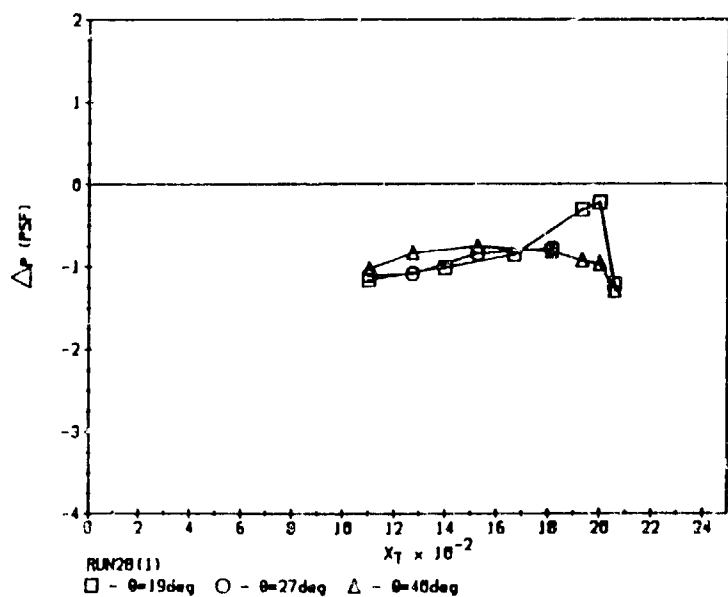
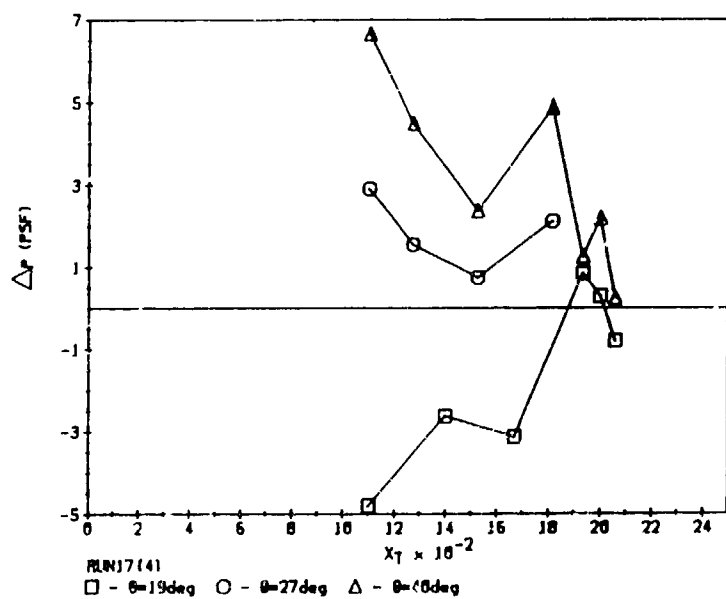


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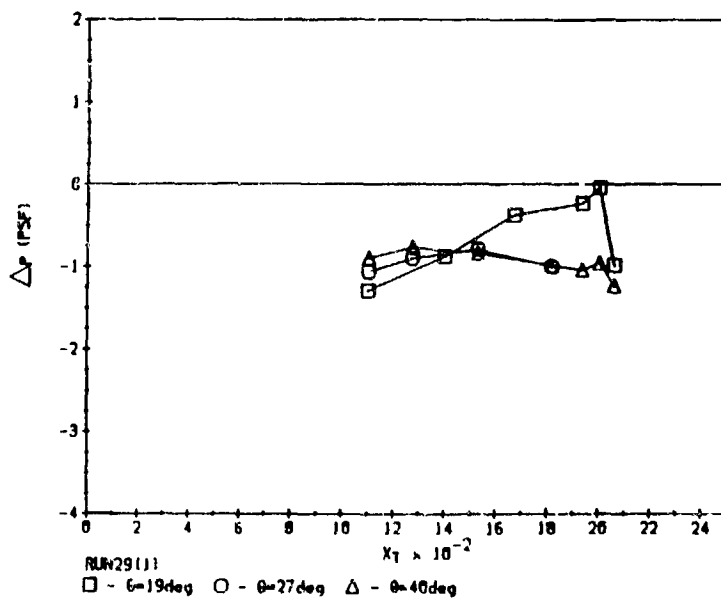
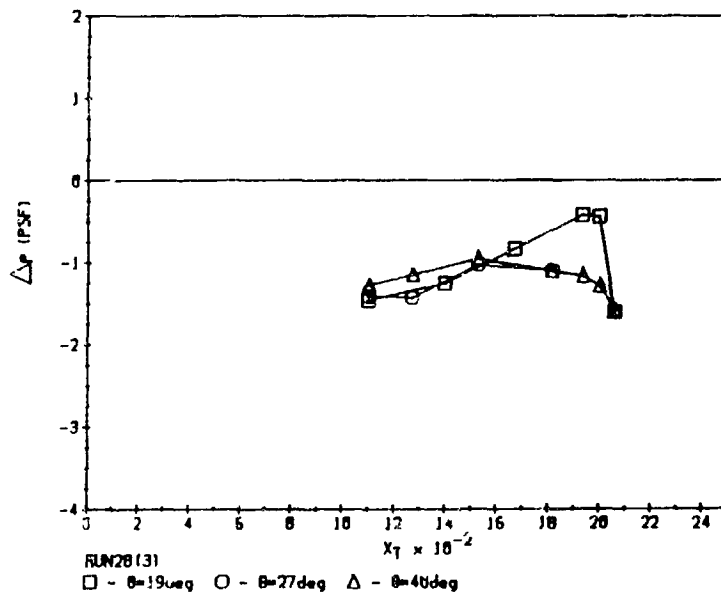
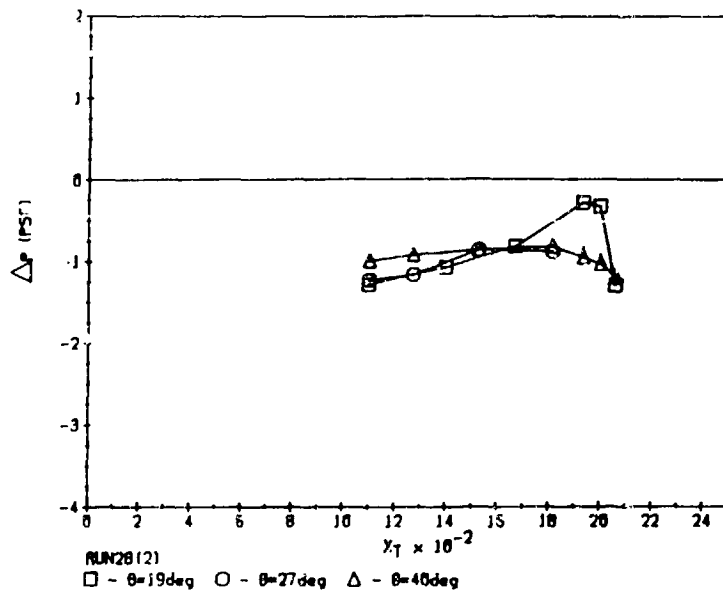




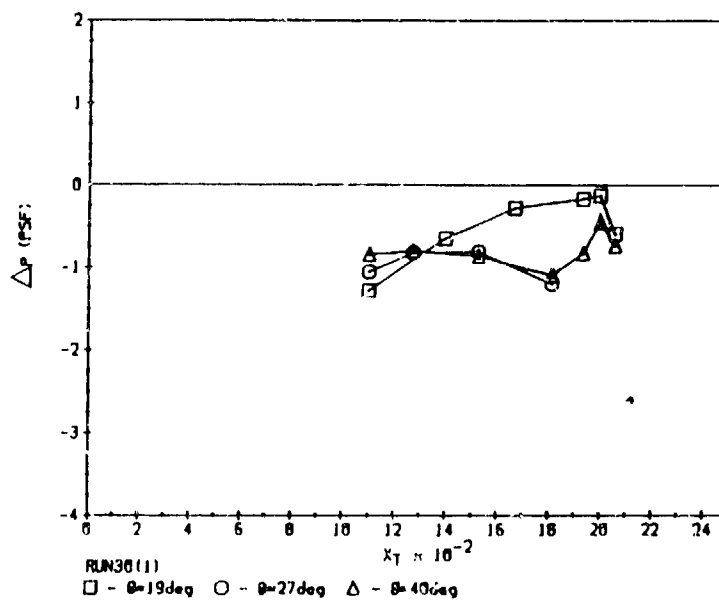
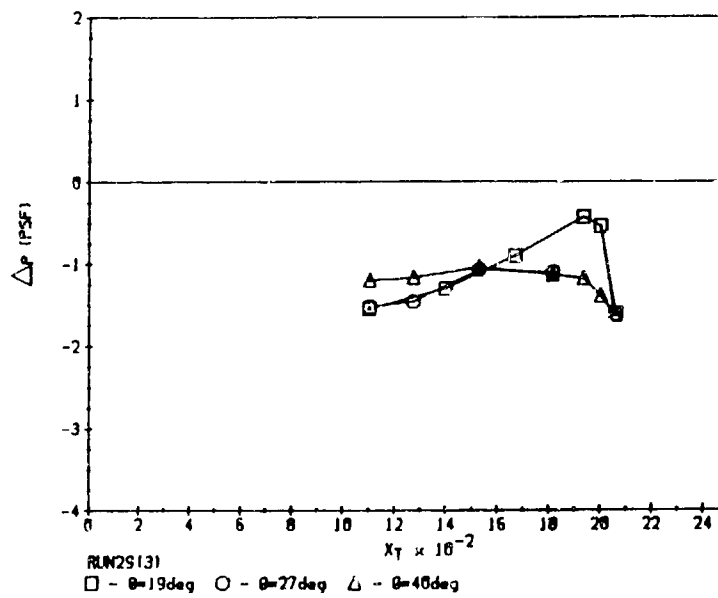
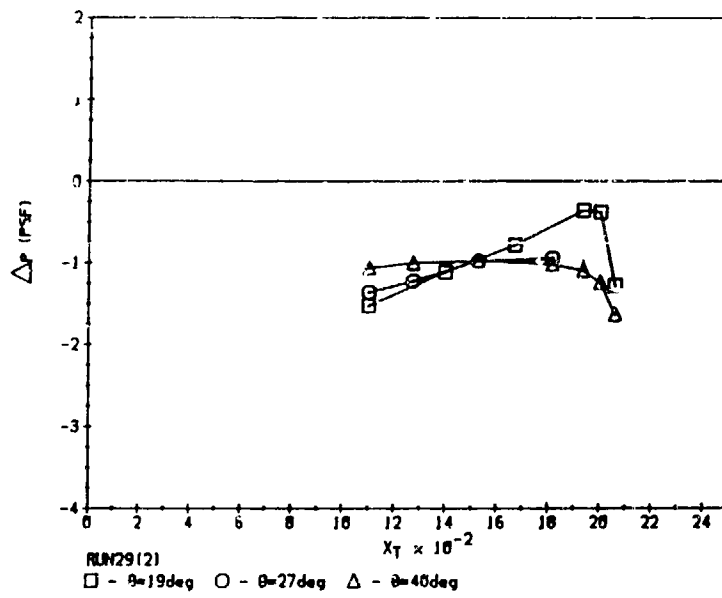
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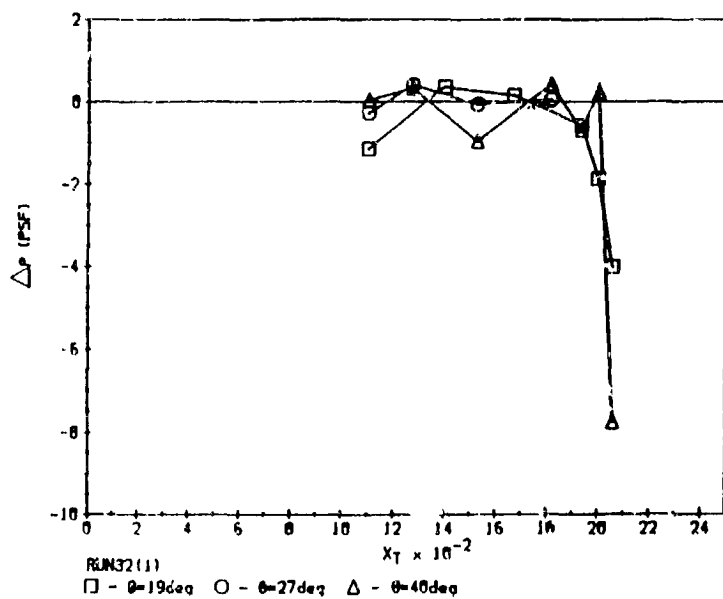
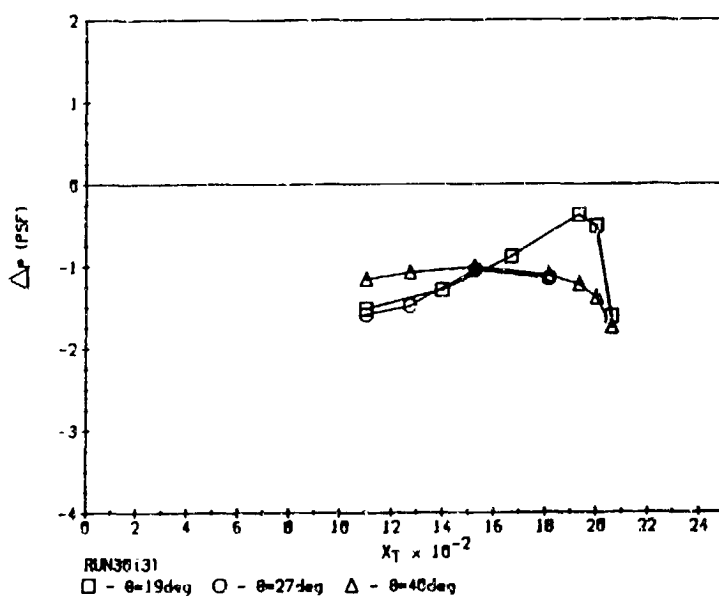
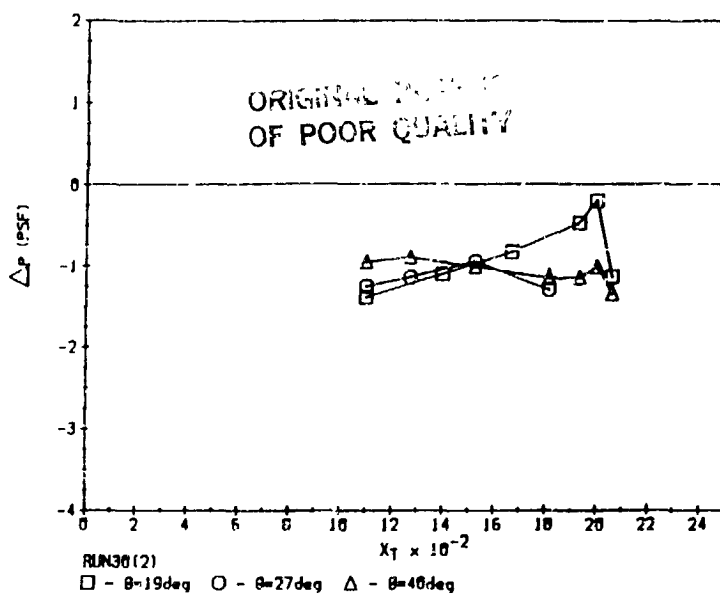


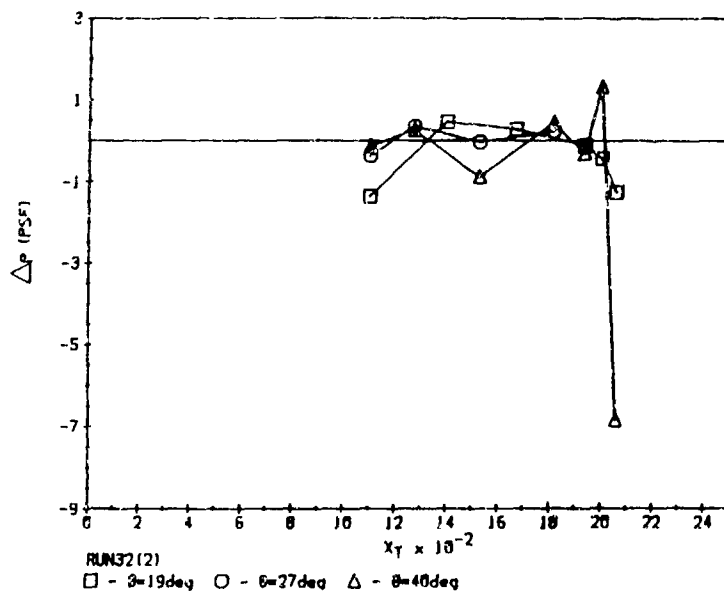
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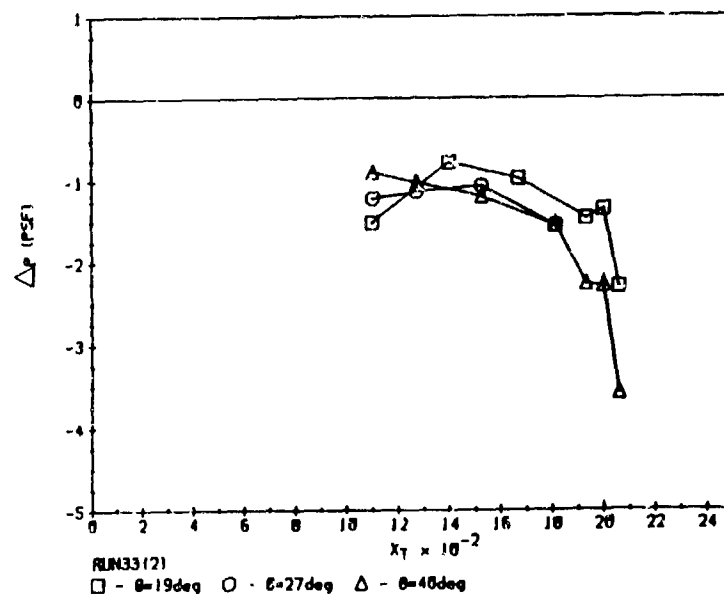
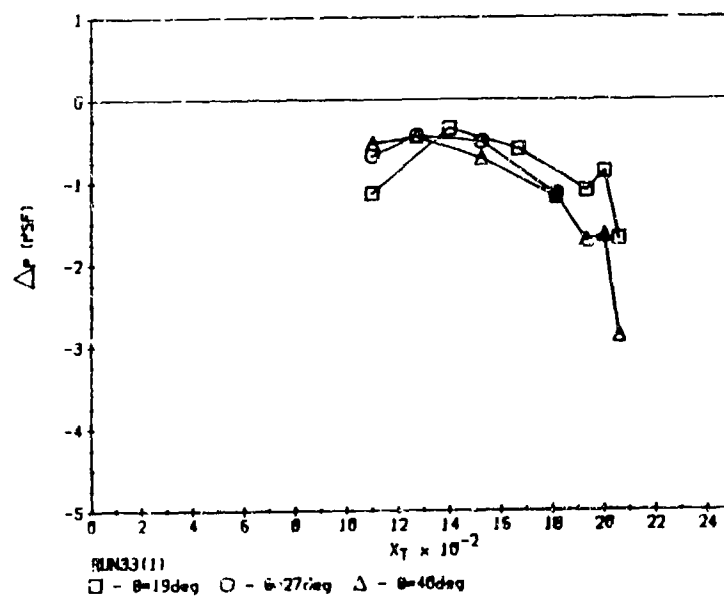
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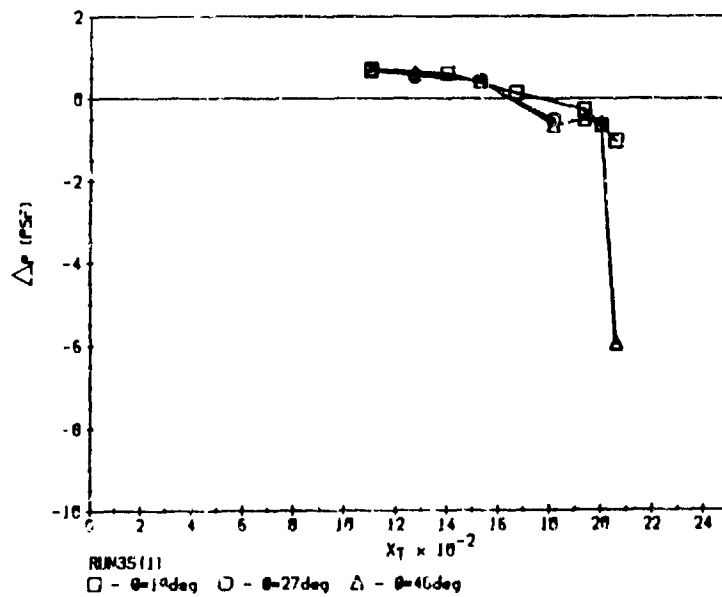
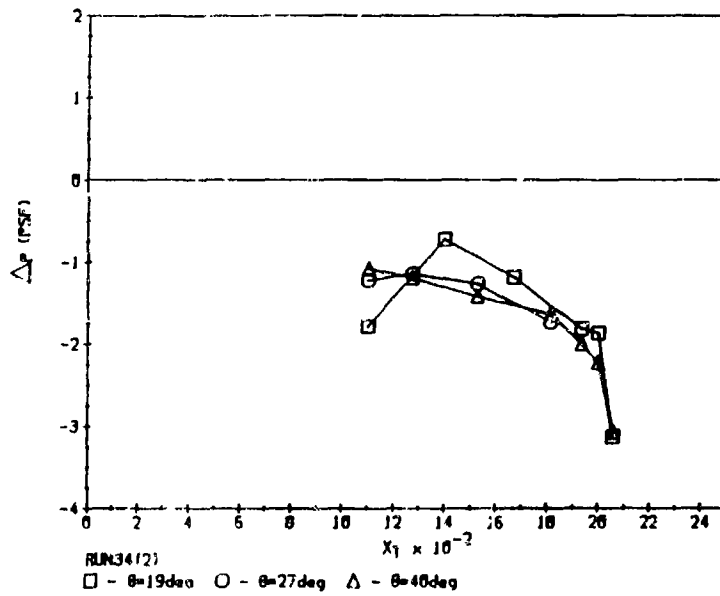
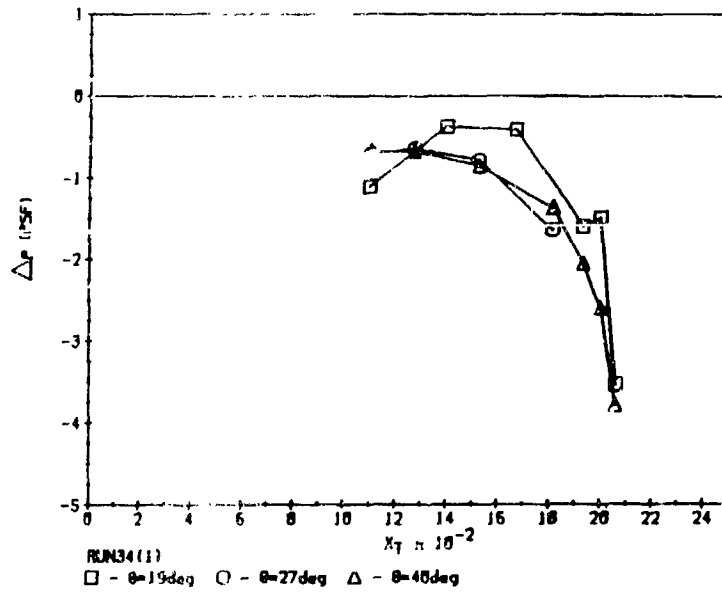




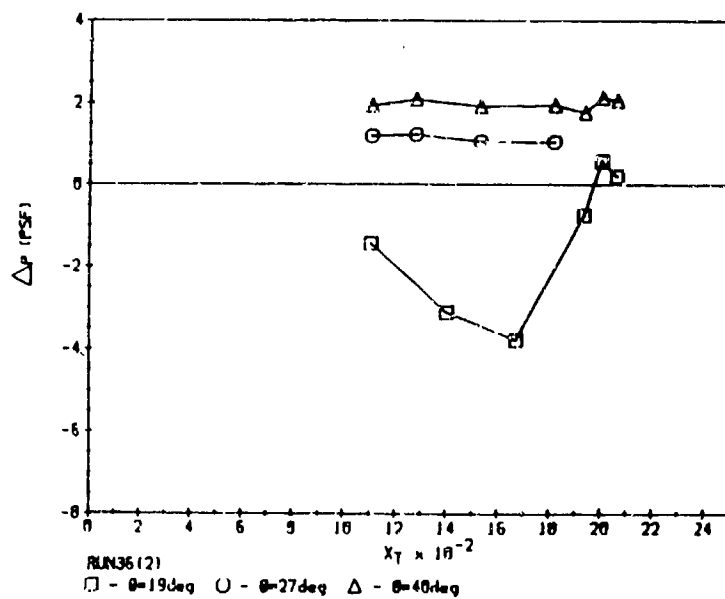
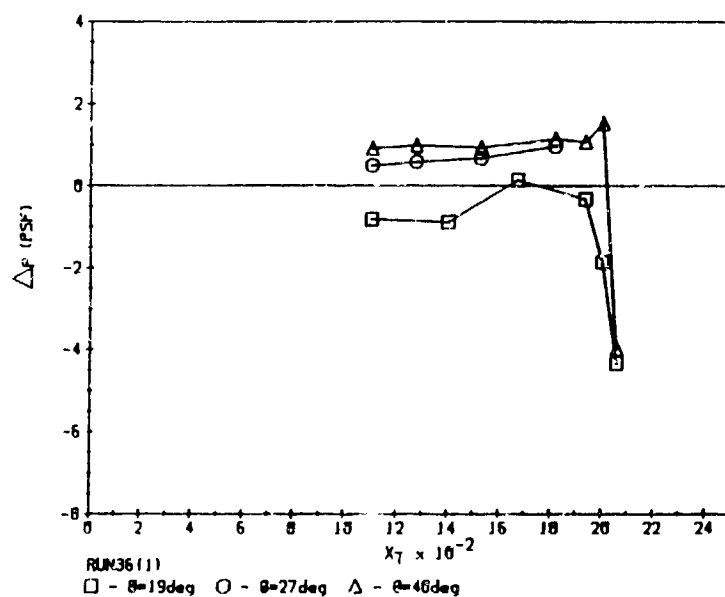
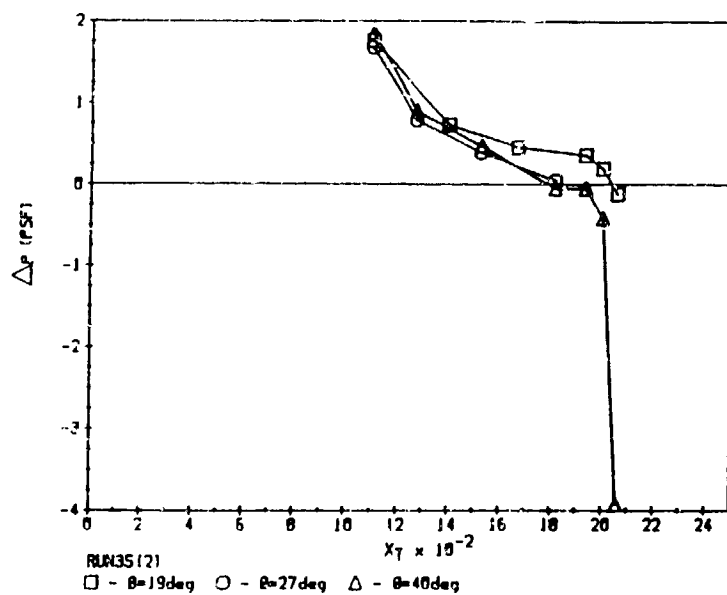
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OF POOR QUALITY



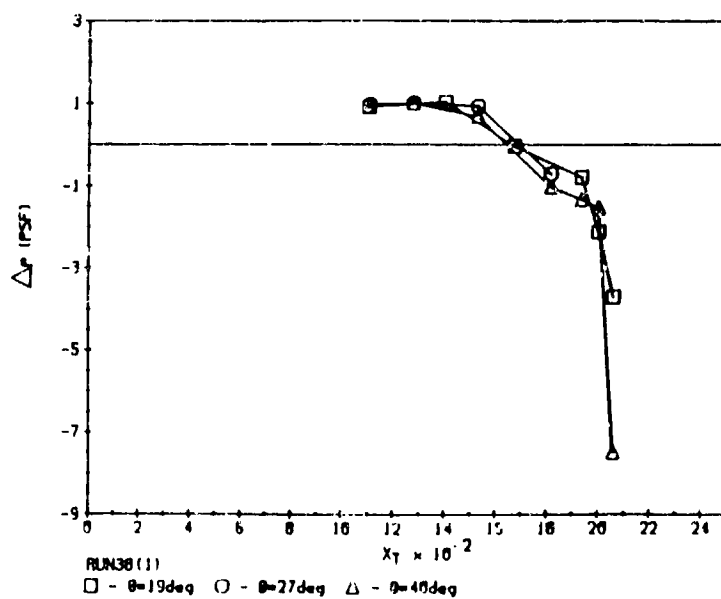
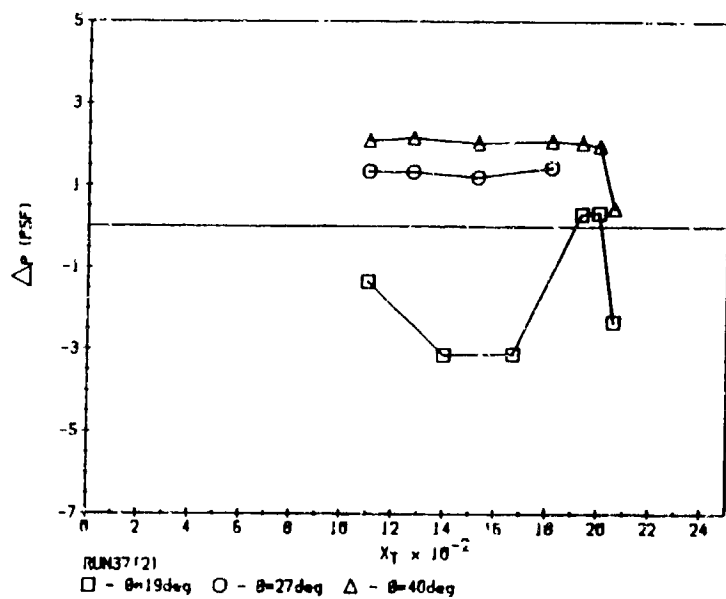
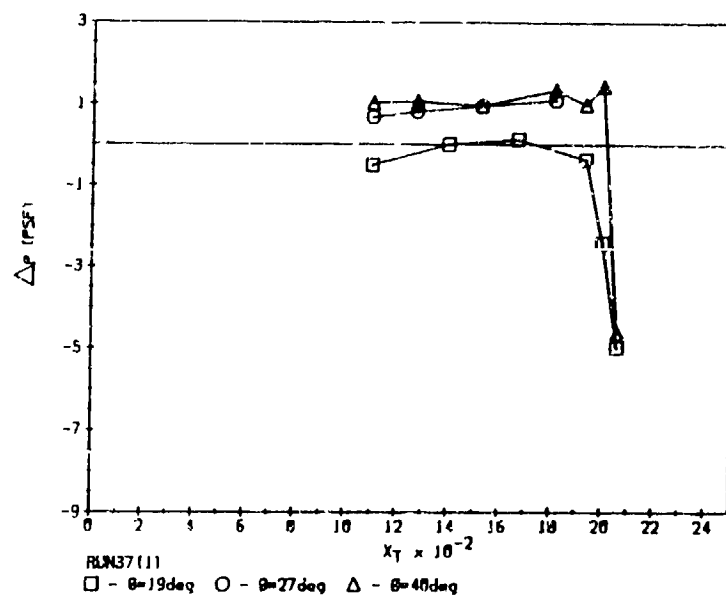
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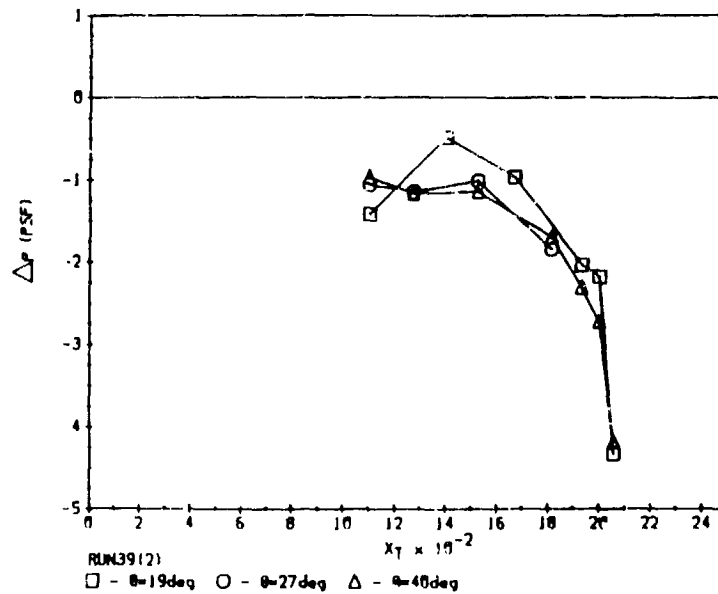
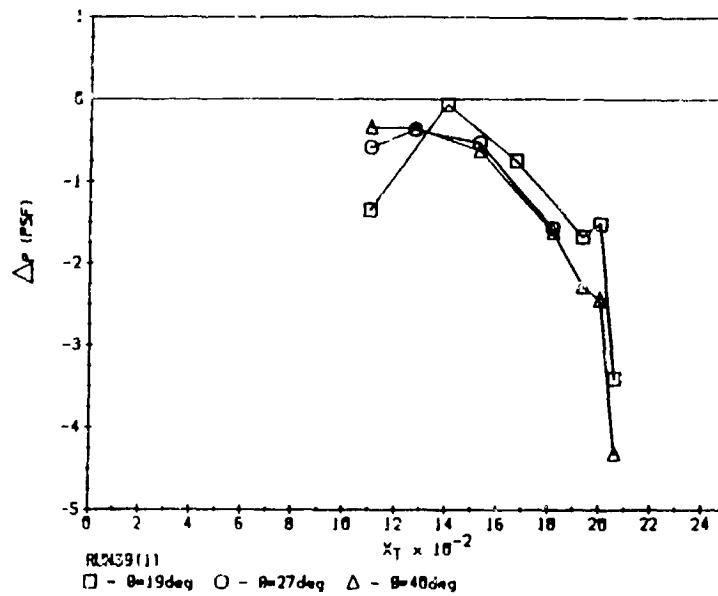
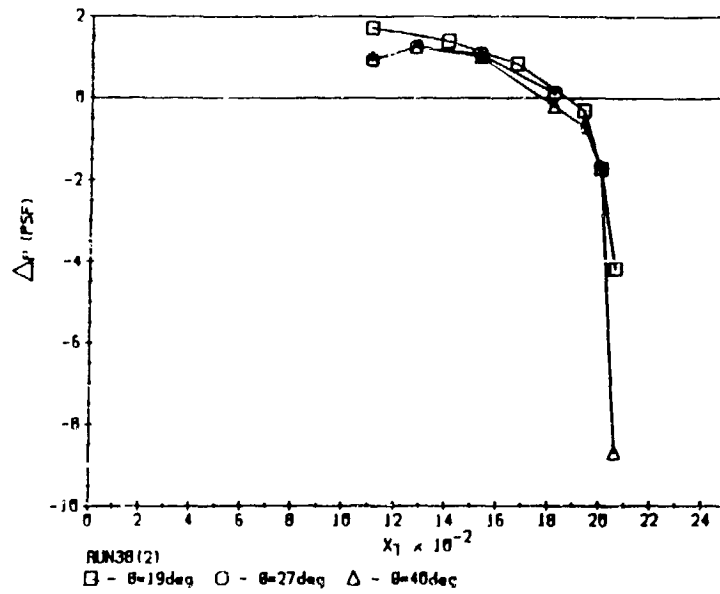
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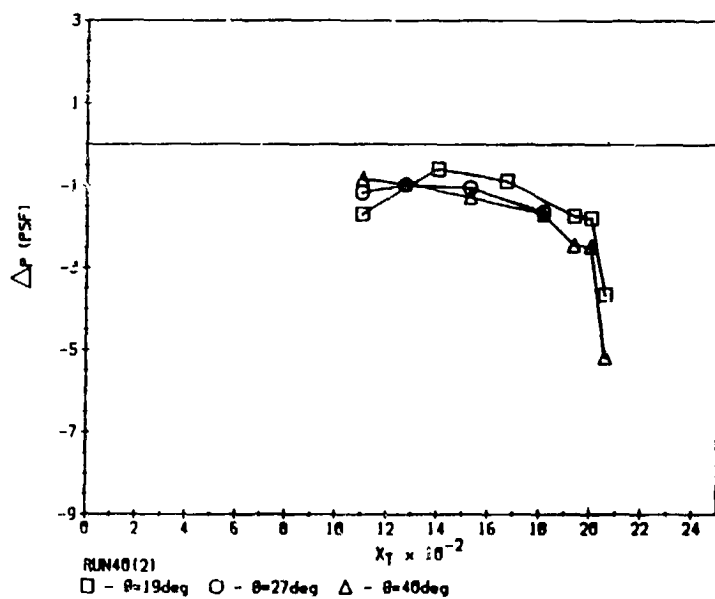
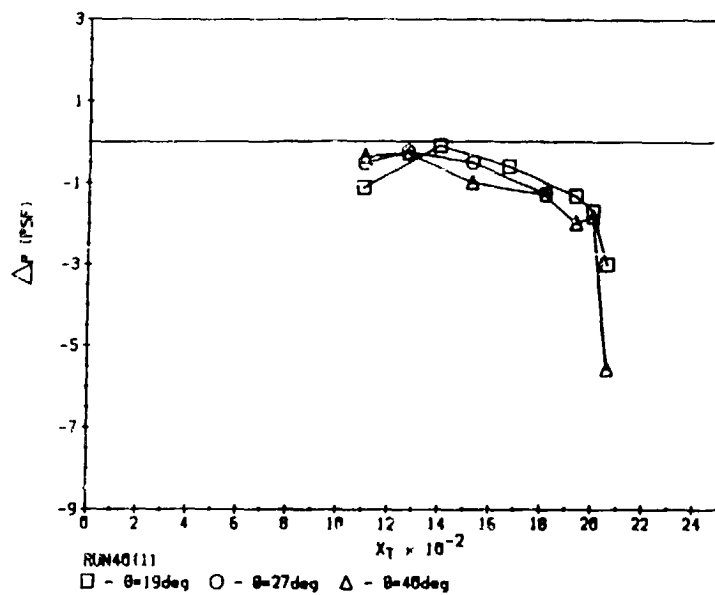
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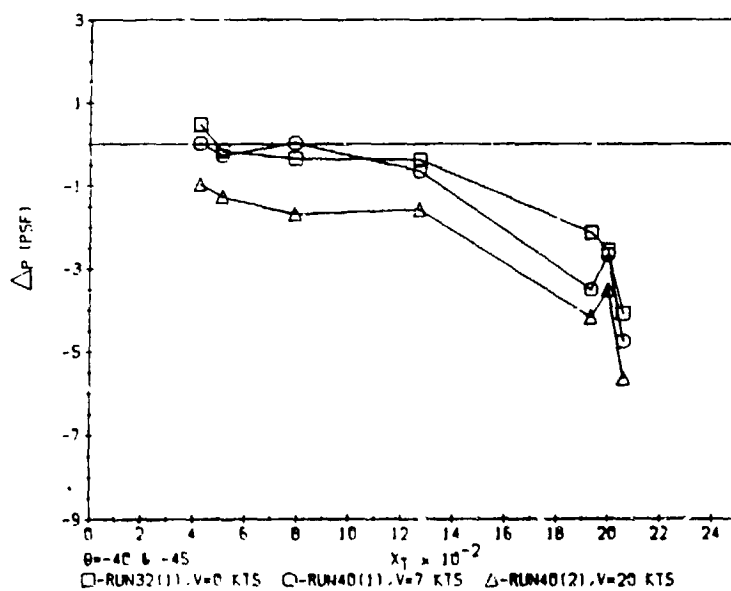
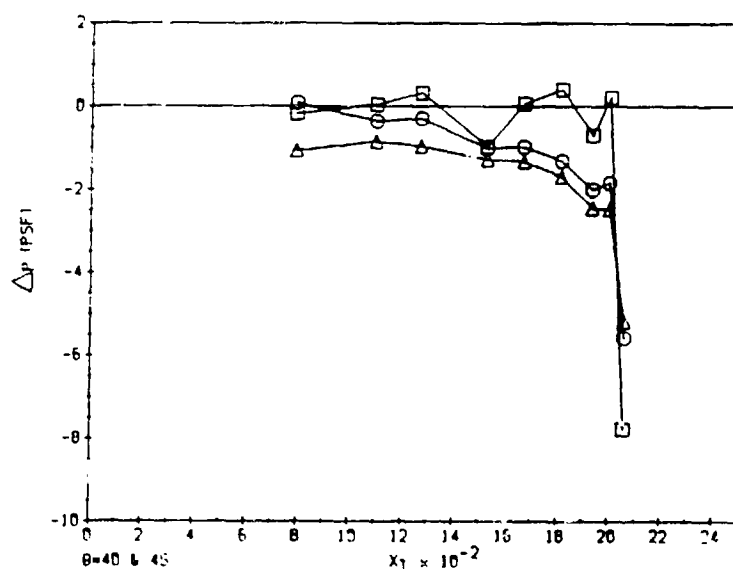
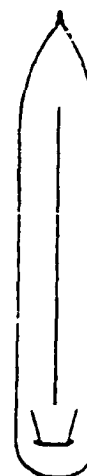
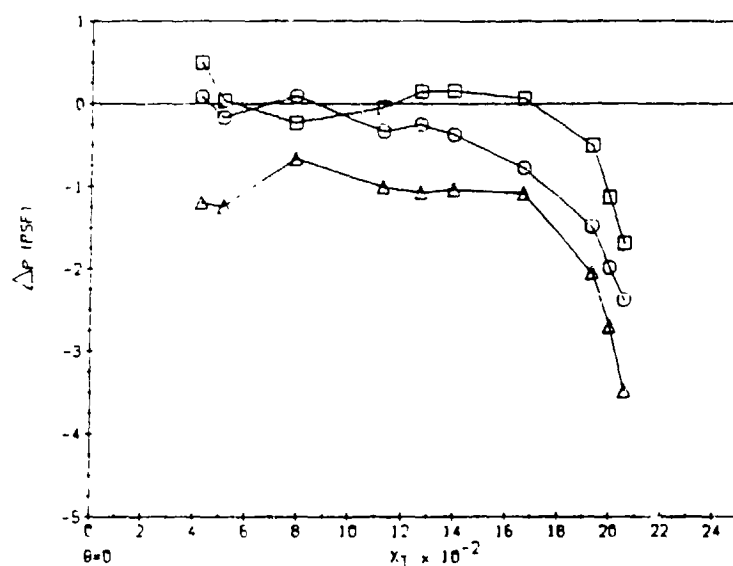
ORIGINAL PAGE 15
OF POOR QUALITY



ORIGINAL PAGE 13
OF POOR QUALITY



ORIGINAL PAGE IS
OF POOR QUALITY



HOT-FILM DATA

NOMINAL CONFIGURATION

WIND ONLY, JETS ONLY, WIND AND JET COMPARISONS

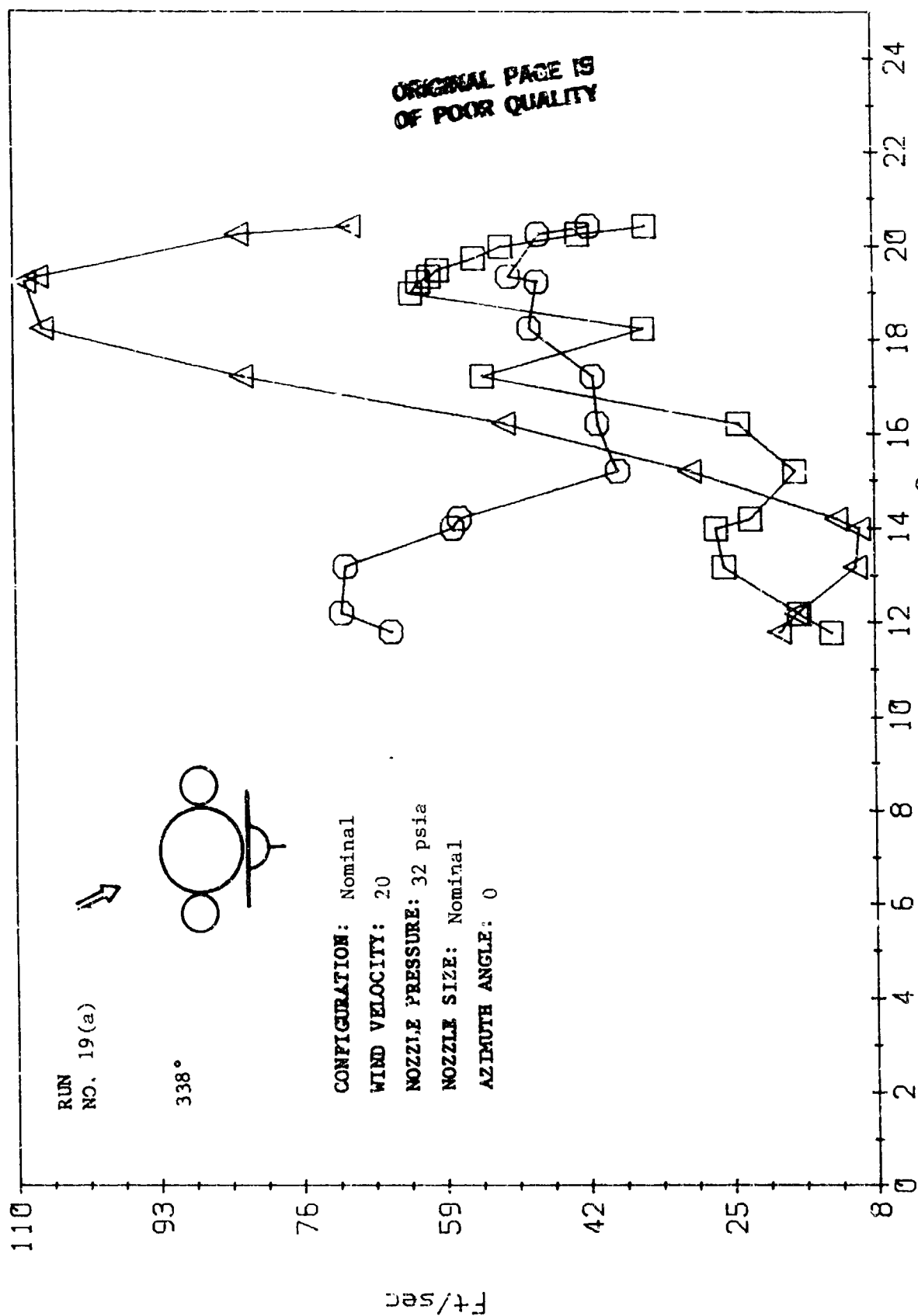
RUNS 19(c), 19(b), 19(a)

$P = 32$ psia N/A on 19(a)

$V = 20$ KNOTS N/A on 19(b)

$\phi = 0^\circ$

$\beta = 338^\circ$ N/A on 19(b)



NOMINAL CONFIGURATION

WIND EFFECTS

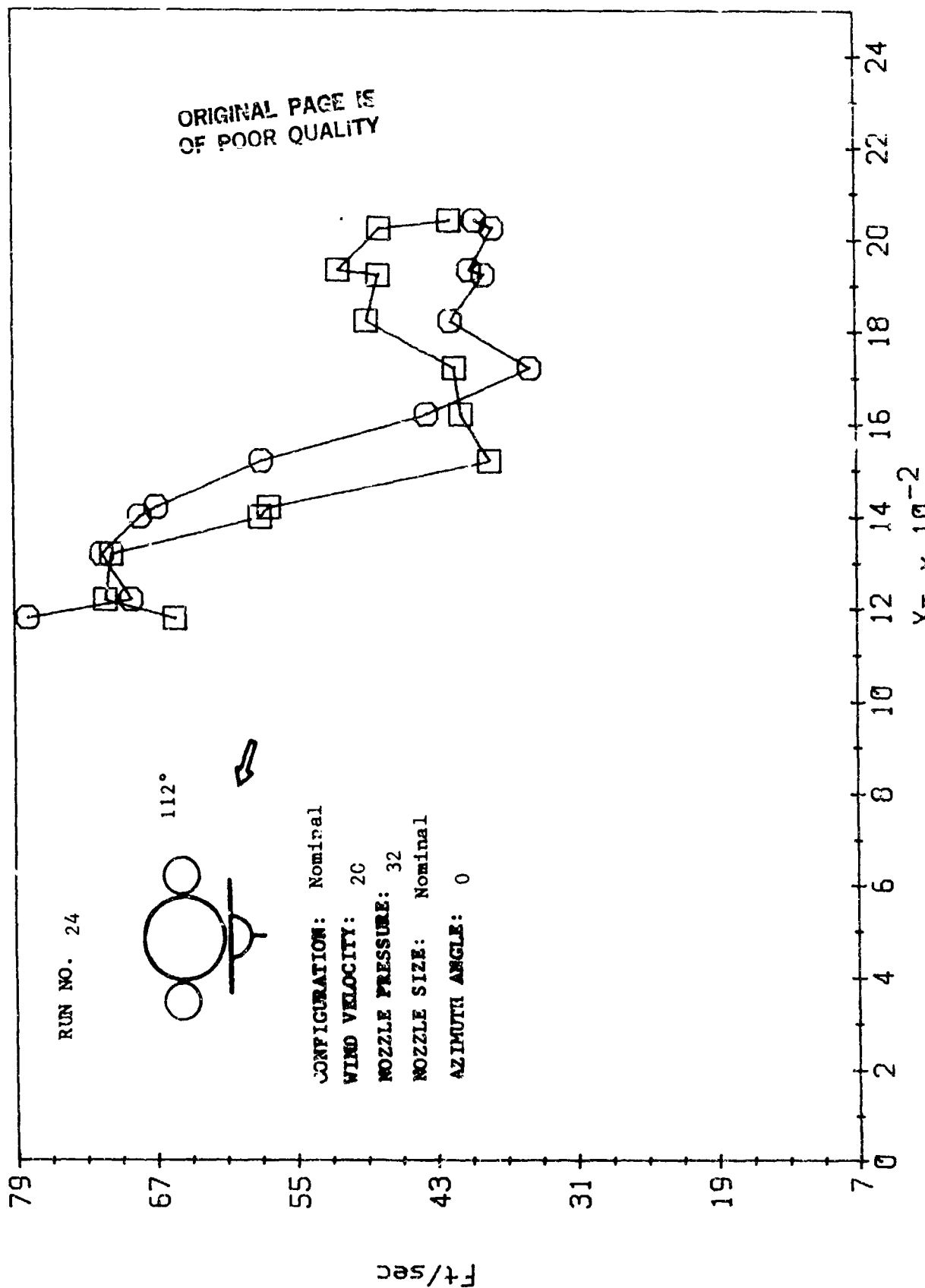
RUNS 19(b), 24

$P = 32 \text{ psia}$

$V = 20 \text{ KNOTS N/A on 19(b)}$

$\phi = 0^\circ$

$\beta = 112^\circ \text{ N/A on 19(b)}$



□-JETS ONLY (32psia) ○-WIND (Beta=112deg) and JETS

RUN 19(b)

RUN 24

NOMINAL CONFIGURATION

VELOCITY SURVEYS

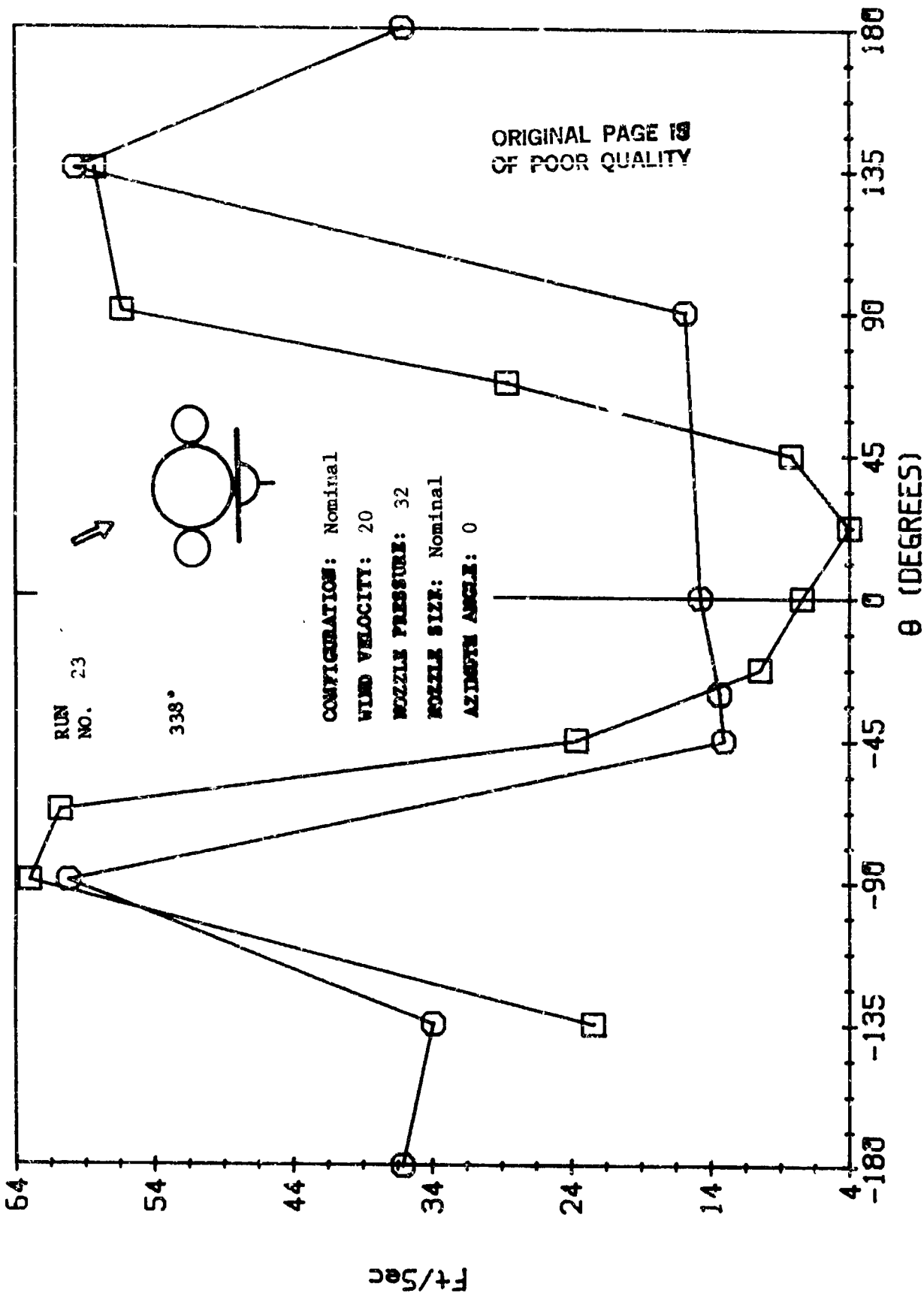
RUN 23

$P = 32 \text{ psia}$

$V = 20 \text{ KNOTS}$

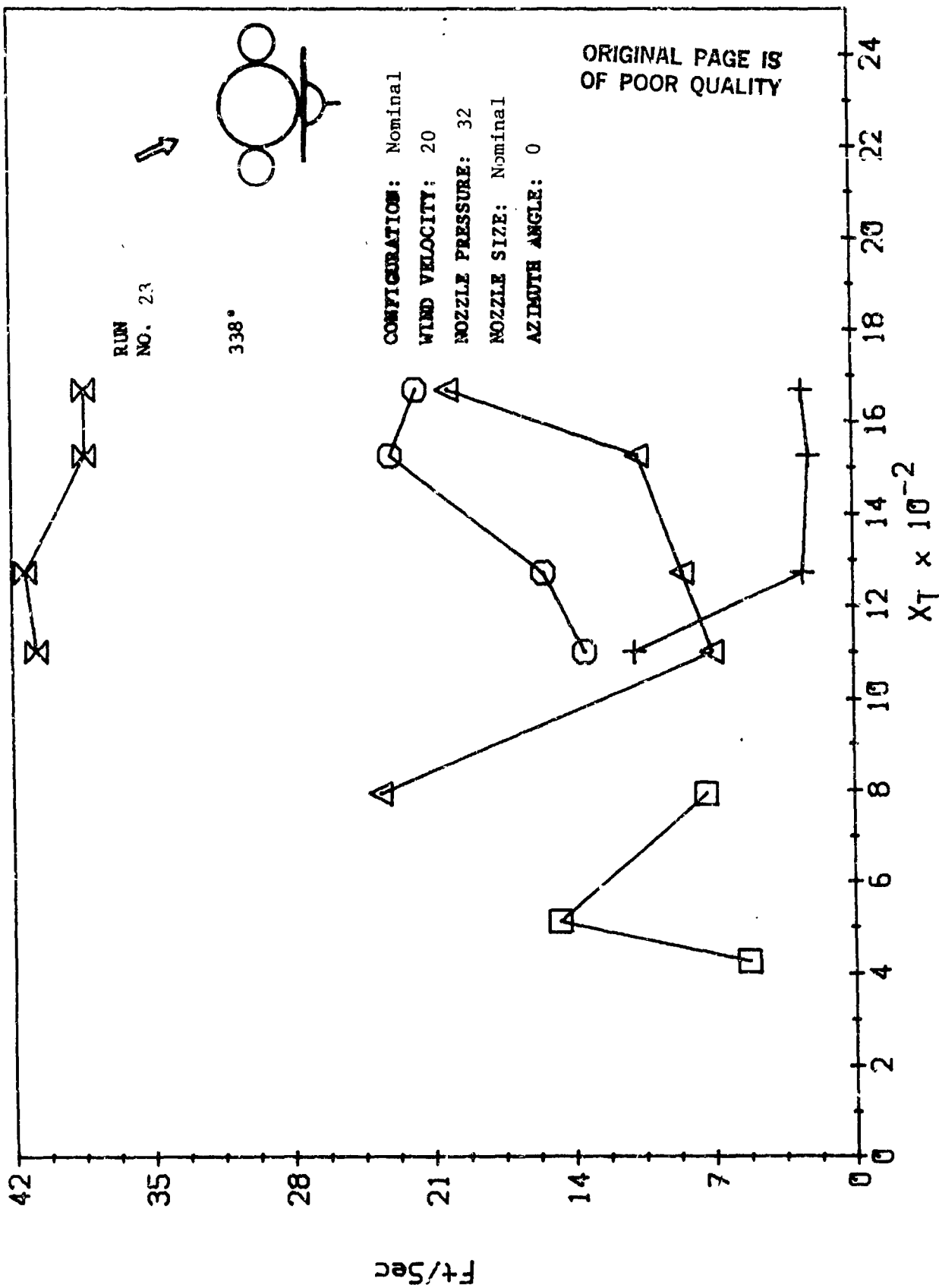
$\phi = 0^\circ$

$\beta = 338^\circ$



RUN23 Velocity Survey

□ - $X_T=793$ ○ - $X_T=514$



□ - θ = 0 ○ - θ = 45 △ - θ = -45
 × - θ = 135 + - θ = -135

RUN 23

MARSHALL SPACE FLIGHT CENTER CONFIGURATION

VELOCITY AND TEMPERATURE SURVEYS

RUN 41.2

$V = 20$ KNOTS

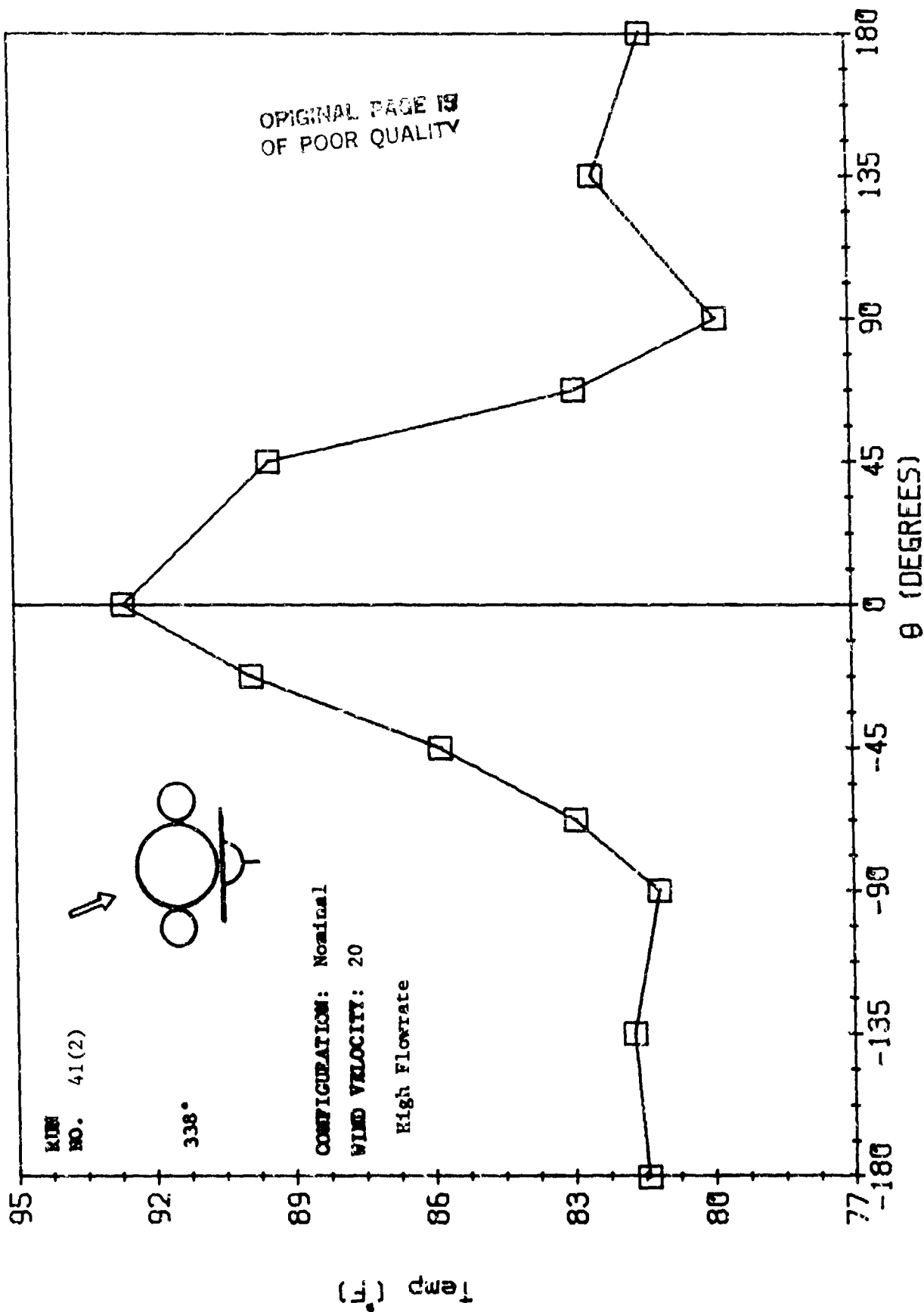
$\beta = 338^\circ$

High Flowrate

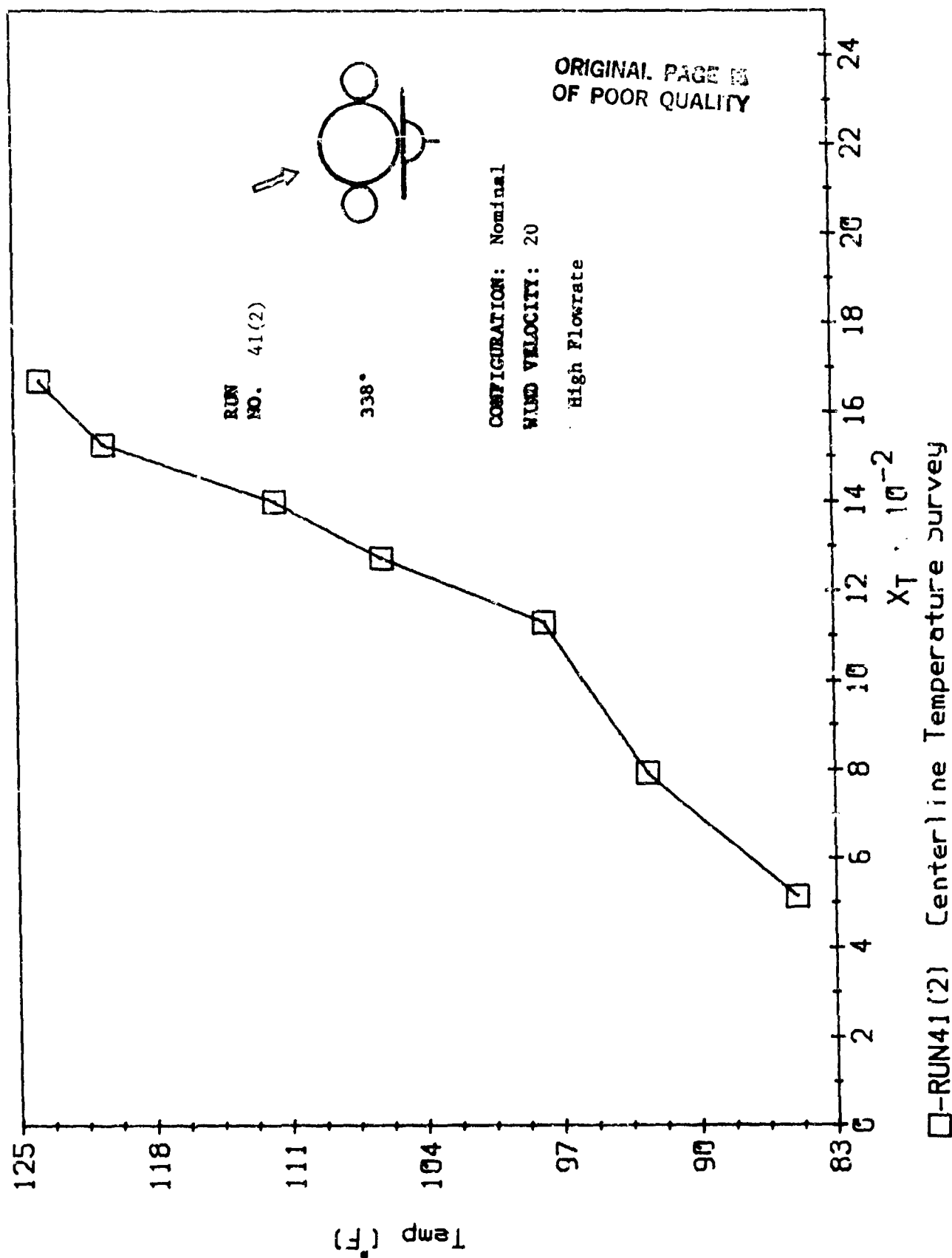
Nozzle Temp. = 197°F

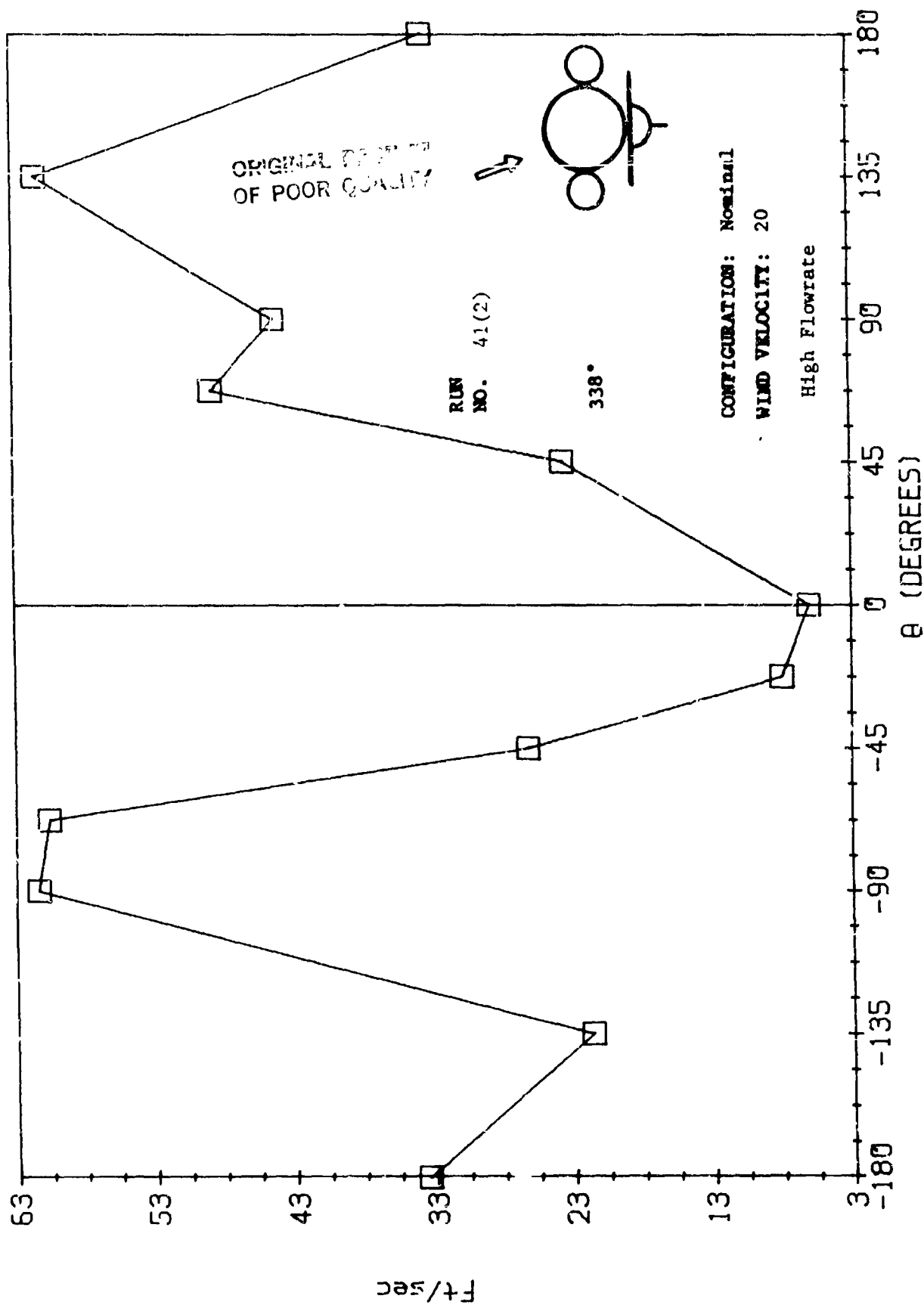
Test Section Temp.

prior to test start - 75°F

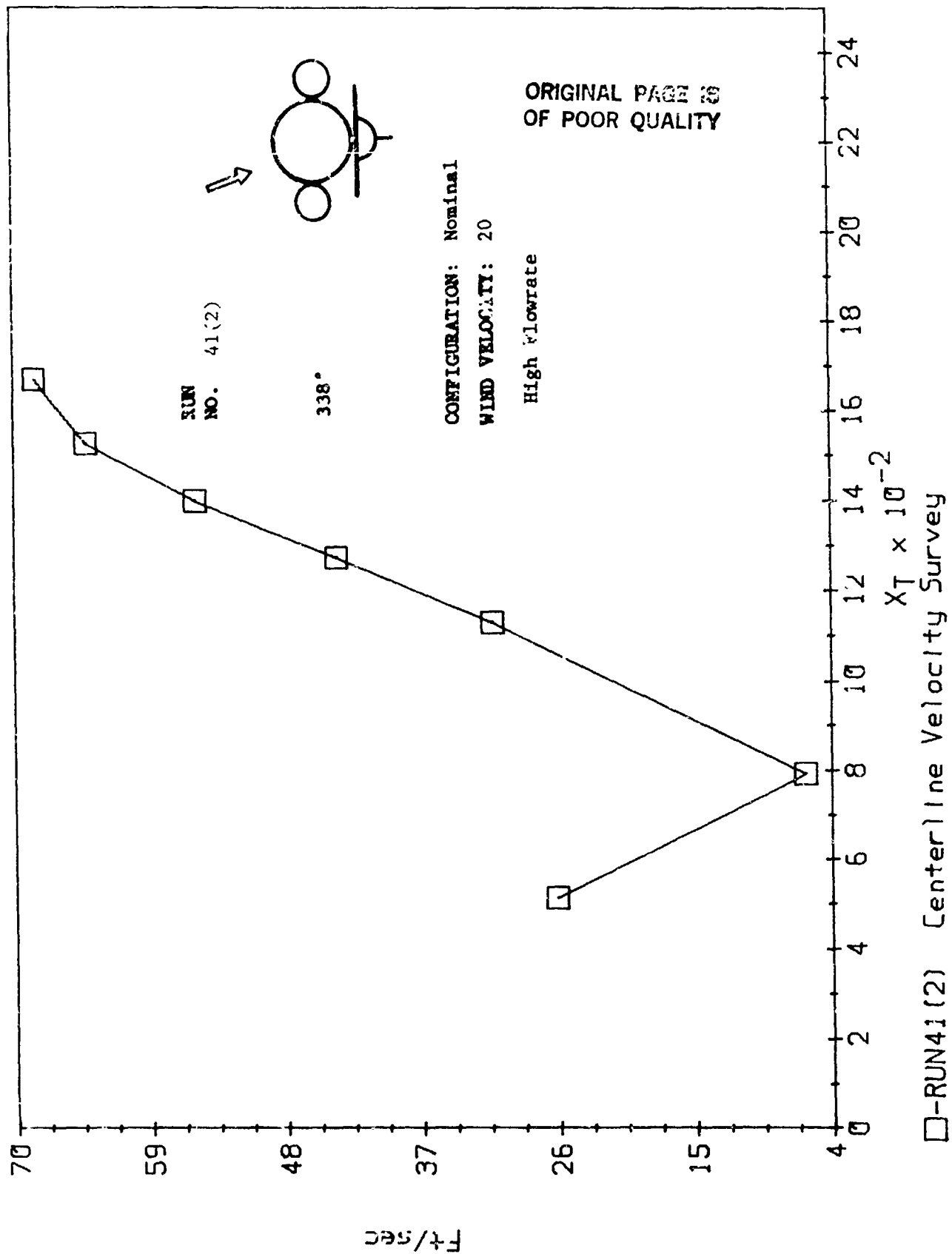


□--RUN41(2) X_T=793 Temperature Survey





□ - RUN 41(2) $X_T=793$ Velocity Survey



MARSHALL SPACE FLIGHT CENTER CONFIGURATION

WIND VELOCITY EFFECTS

RUNS 42, 43

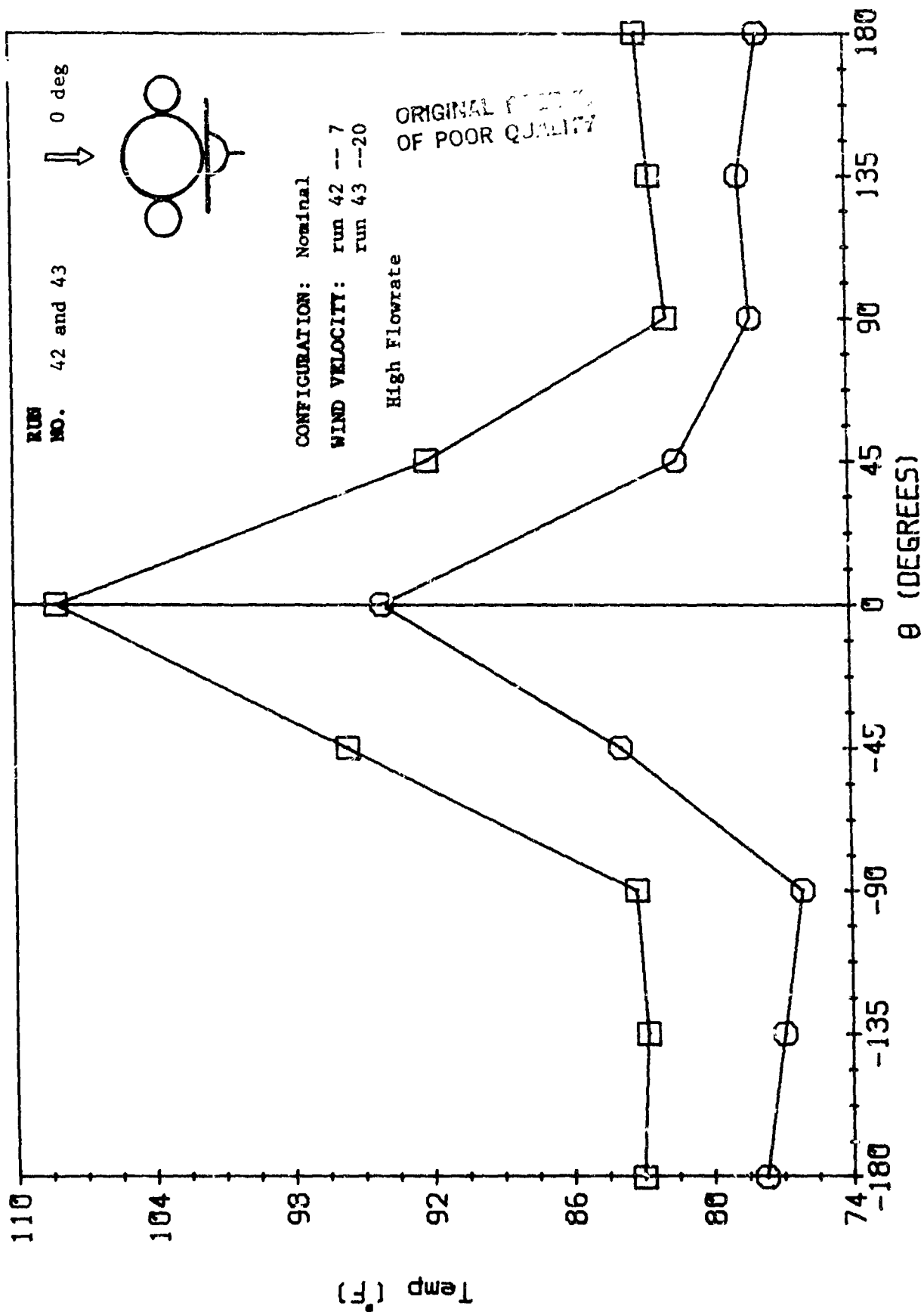
$\beta = 0^\circ$

High Flowrate

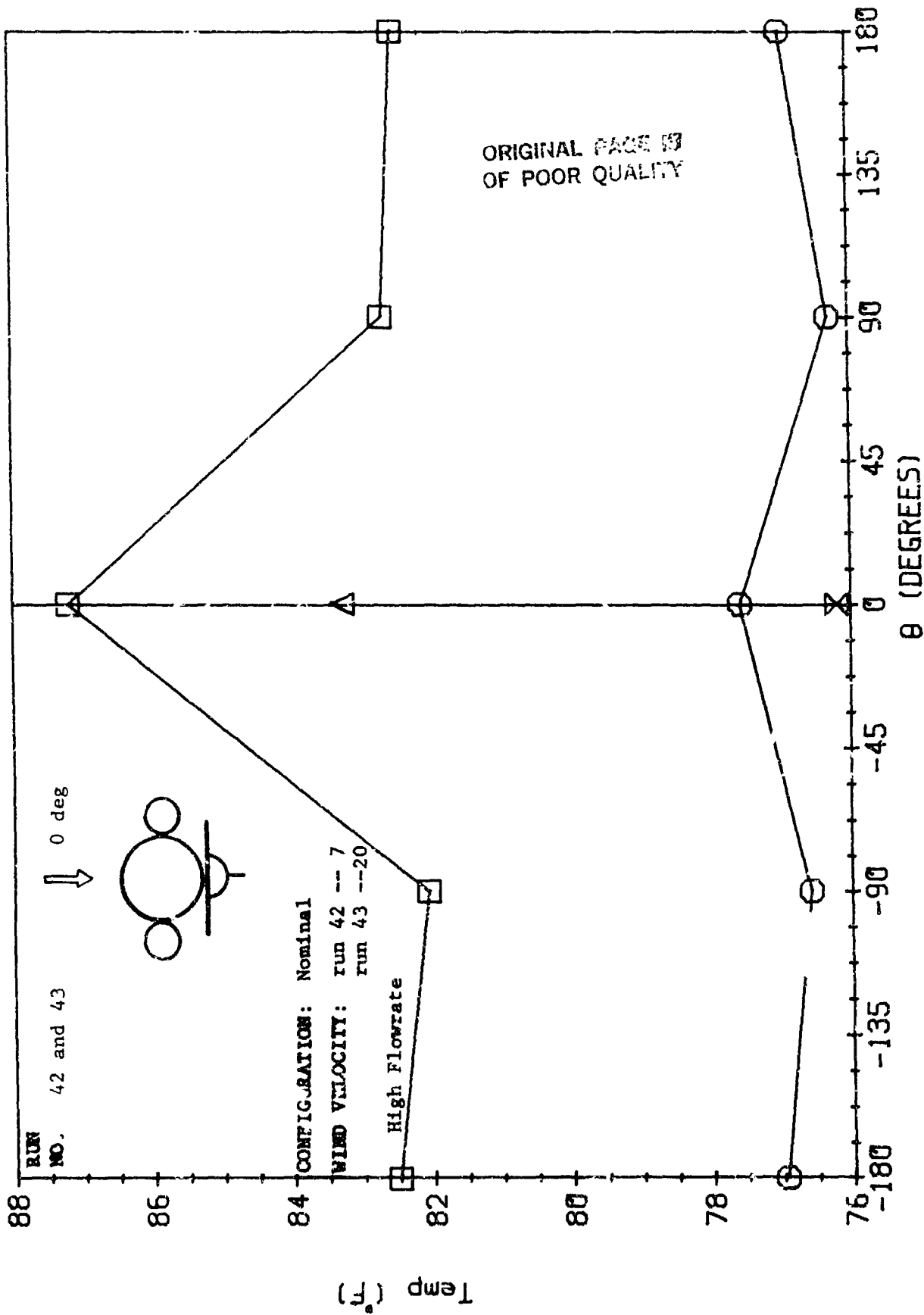
Nozzle Temp. = 197°F

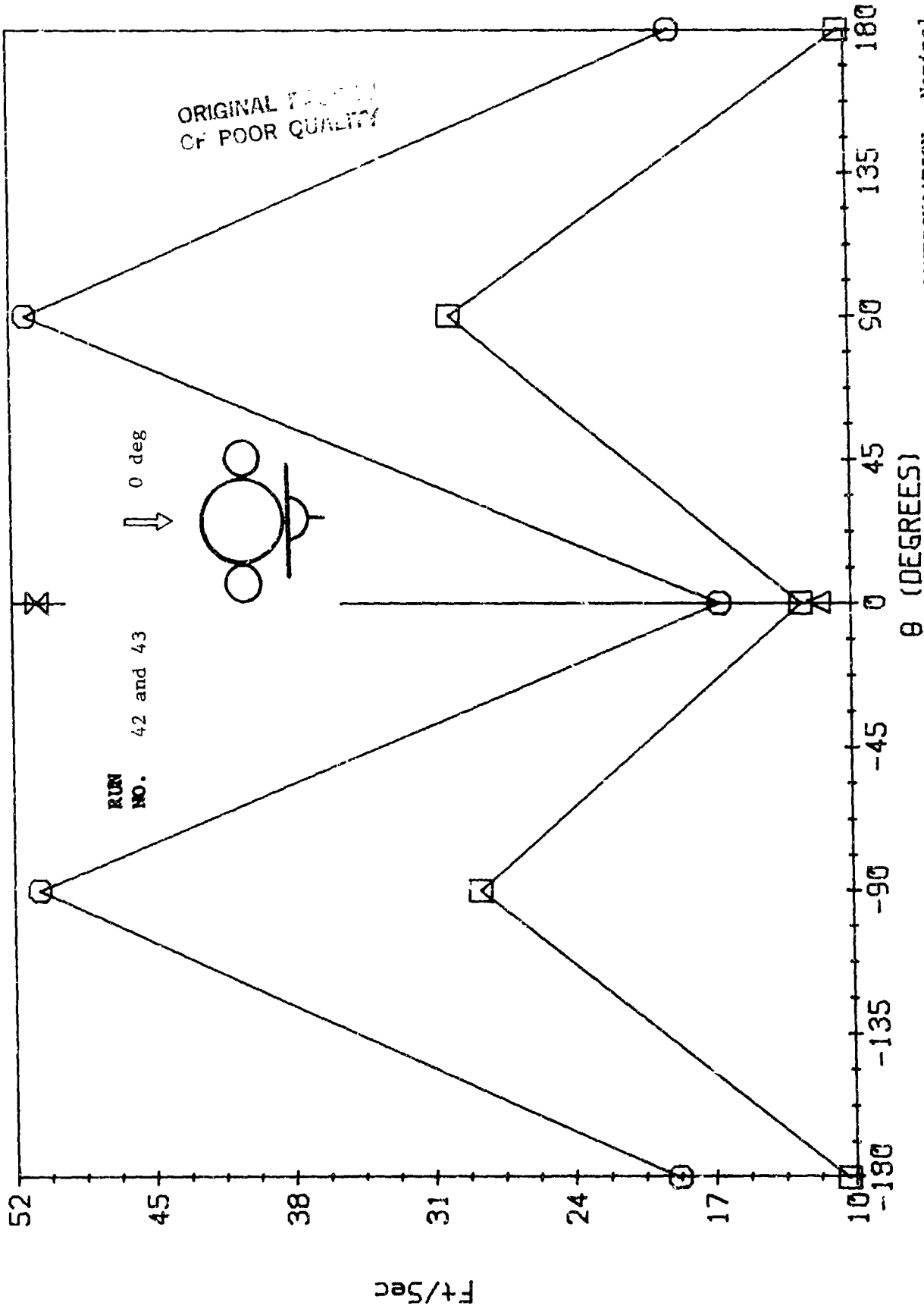
Test Section Temp.

prior to test start = 75°F



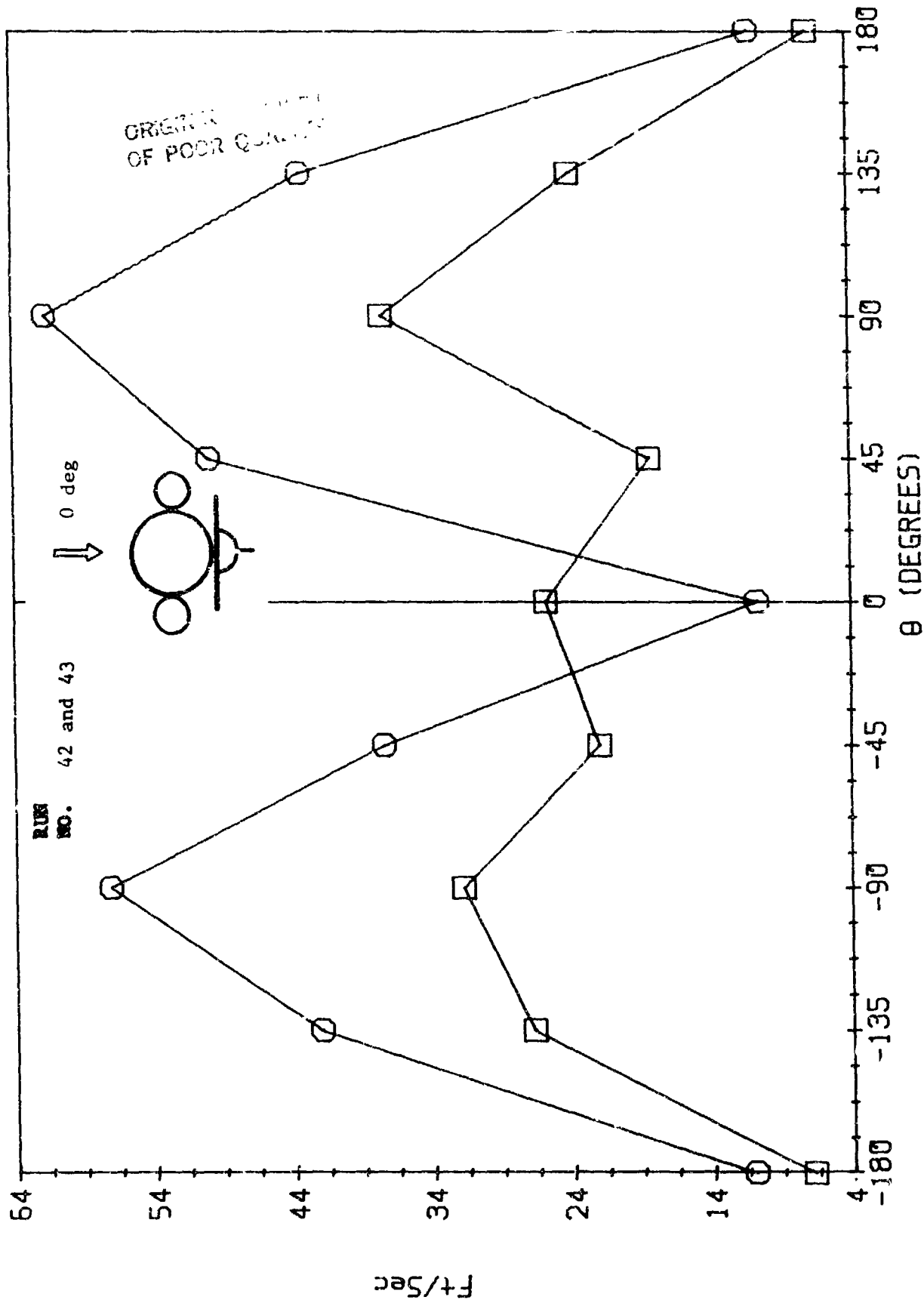
□-RUN42 V=7KTS ○-RUN43 V=20KTS





CONFIGURATION: Nominal
WIND VELOCITY: run 42 -- 7
run 43 -- 20
High Flowrate

□-RUN42 V=7KTS O-RUN43 V=20KTS Δ-ET NOSE V=7KTS
X-ET NOSE V=20KTS



CONFIGURATION: Nominal
 WIND VELOCITY: run 42 -- 7
 run 43 -- 20

□-RUN42 V=7KTS ○-RUN43 V=20KTS

High Flowrate